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A HEURISTIC APPROACH FOR IMAGE COMPRESSION USING WAVELET TRANSFORM

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ABSTRACT

Recently, due to the advances in the technology, the reliance on computers is growing and so is the need to store the enormous amount of digital data. However, the storage space available is still limited so to meet the growing demand of storing huge data efficiently the images need to be compressed before storage. The compressed image needs to be recovered at the time when required so there is required a tradeoff between compression ratios of images and the loss the image suffers through. So, in this paper, an algorithm has been discussed which gives the best results in terms of compression ratio as well as image quality. This heuristic approach uses Haar wavelet using SPIHT algorithm for image compression. This is expected to meet the demand of the future systems.

Keywords: Image Compression, Haar Wavelet, SPIHT, MATLAB

I. INTRODUCTION

In today's technological world as our use of and reliance on computers continues to grow, so too do our need for efficient ways of storing large amounts of data and due to the bandwidth and storage limitations, images must be compressed before transmission and storage. For example, someone with a web page or online catalog that uses dozens or perhaps hundreds of images will more than likely need to use some form of image compression to store those images. This is because the amount of space required to hold unadulterated images can be prohibitively large in terms of cost. Fortunately, there are several methods of image compression available today. This fall into two general categories: lossless and lossy image compression.

However, the compression will reduce the image fidelity, especially when the images are compressed at lower bit rates. The reconstructed images suffer from blocking artifacts and the image quality will be severely degraded under the circumstance of high compression ratios. In order to have a good compression ratio without losing too much of information when the image is decompressed we use DCT. In computer science and information theory, data compression or source coding is the process of encoding information using fewer bits. Compression is useful because it helps reduce the consumption of expensive memory. There are two types of image compression: lossless and lossy. With lossless compression, the original image is recovered exactly after decompression. Much higher compression ratio scan is obtained if some error, which is usually difficult to perceive, is allowed between the decompressed image and the original image. This is lossy compression. In computing, JPEG is a commonly used method of lossy compression for digital photography (image). The degree of compression can be adjusted, allowing selectable tradeoffs between storage size and image quality. JPEG typically achieves 10:1 compression with little perceptible loss in image quality.JPEG compression is used in a number of image file formats. JPEG is the most common image format used by digital cameras and other photographic image capture devices; along with JPEG/JFIF, it is the most common format for storing and transmitting photographic images on the World Wide Web. These format variations are often not distinguished, and are simply called JPEG. The term "JPEG" is an acronym for the Joint Photographic Experts Group. The JPEG compression algorithm is at its best on photographs and paintings of realistic scenes with smooth variations of tone and color. For web usage, where the amount of data used for an image is important. JPEG 2000 is an image compression standard and coding system. It was created by the Joint Photographic Experts Group committee in 2000 with the intention of superseding their original discrete cosine transform-based JPEG standard (created in 1992) with a newly designed, wavelet-based method. In this paper, we are compressing the image with the help of image processing toolbox in MATLAB.

II. WAVELET BASED IMAGE COMPRESSION

Discrete Wavelet Transform (DWT) provides a multi resolution image representation and has become one of the most important tools in image analysis and coding over the last two decades. Image compression algorithms based on DWT provide high coding efficiency for natural (smooth) images. As dyadic DWT does not adapt to the various space-frequency properties of images, the energy compaction it achieves is generally not optimal. However, the performance can be improved by selecting the transform basis adaptively to the image. Wavelet Packets (WP) represent a generalization of wavelet decomposition scheme. WP image decomposition adaptively selects a transform basis that will be best suited to the particular image. To achieve that, the criterion for best basis selection is needed.

Coif man and Wickerhauser proposed entropy based algorithm for best basis selection [1]. In their work, the best basis is a basis that describes the particular image with the smallest number of basic functions. It is a one-sided metric, which is therefore not optimal in a joint rate-distortion sense. A more practical metric considers the number of bits (rate) needed to approximate an image with a given error (distortion) but this approach and its variation presented in can be computationally too intensive. In a fast numerical implementation of the best wavelet packet algorithm is provided. Coding results show that fast wavelet packet coder can significantly outperform a sophisticated wavelet coder constrained to using only a dyadic decomposition, with a negligible increase in computational load.

2.1 HAAR Wavelet

A wavelet is a wave-like oscillation with amplitude that starts out at zero, increases, and then decreases back to zero. It can typically be visualized as a "brief oscillation" like one might see recorded by a seismograph or heart monitor. Generally, wavelets are purposefully crafted to have specific properties that make them useful for signal processing. Wavelets can be combined, using a "shift, multiply and sum" technique called convolution, with portions of an unknown signal to extract information from the unknown signal.

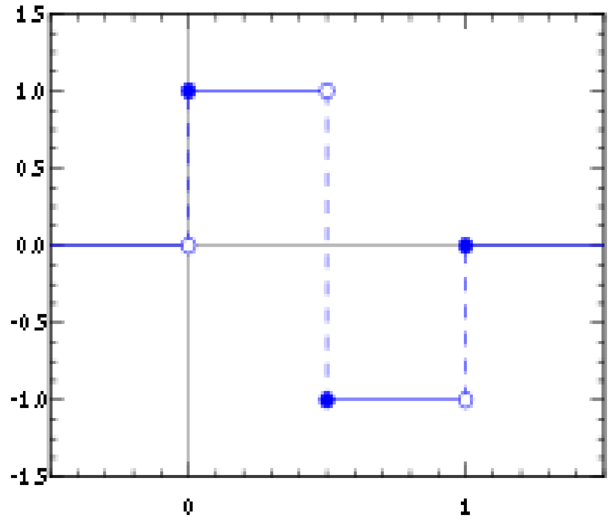

Fig. 1. The Haar wavelet

In mathematics, the Haar wavelet is a certain sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. Wavelet analysis is similar to Fourier analysis in that it allows a target function over an interval to be represented in terms of an orthonormal function basis. The Haar sequence is now recognized as the first known wavelet basis and extensively used as a teaching example in the theory of wavelets. 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 ψ(t) can be described as

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

Its scaling function φ(t) can be described as

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

This property can, however, be an advantage for the analysis of signals with sudden transitions, such as monitoring of tool failure in machines [2].

III. SPIHT ALGORITHM

SPIHT (Set Partitioning In Hierarchical Tree) Algorithm is the modified and extended version of EZW (Embedded Zero Tree Wavelet). This algorithm work with tree structure, called Spatial Orientation Tree (SOT) that defines the spatial relationships among wavelet coefficients in different decomposition sub bands. Wavelet analysis of an image can be viewed in the frequency domain as partitioning into set of sub bands where each partitioning step is obtained by applying the 2D wavelet transform. One level of 2D wavelet transform results in four sets of data (wavelet coefficients), that corresponds to four 2D frequency sub bands HHK (High-High or diagonal details), HLK (High-Low or horizontal details), LHK (Low-High or vertical details) and LLK (Low-Low or approximation).

Image compression techniques, especially non-reversible or lossy ones, have been known to grow computationally more complex as they grow more efficient, confirming the tenets of source coding theorems in information theory that a code for a (stationary) source approaches optimality in the limit of infinite computation (source length). Notwithstanding, the image coding technique called embedded zero tree wavelet (EZW), introduced by Shapiro [3], interrupted the simultaneous progression of efficiency and complexity. This technique not only was competitive in performance with the most complex techniques, but was extremely fast in execution and produced an embedded bit stream. With an embedded bit stream, the reception of code bits' can be stopped at any point and the image can be decompressed and reconstructed.

The EZW technique is based on three concepts:

(1) Partial ordering of the transformed image elements by magnitude, with transmission of order by a subset partitioning algorithm that is duplicated at the decoder,

(2) Ordered bit plane transmission of refinement bits, and

(3) Exploitation of the self-similarity of the image wavelet transform across different scales. The partial ordering is a result of comparison of transform element (coefficient) magnitudes to a set of actively decreasing thresholds. An element is significant or insignificant with respect to a given threshold, depending on whether or not it exceeds that threshold.

The subset partitioning is so effective and the significance information so compact that even binary un-coded transmission achieves about the same or better performance than in these previous works. Moreover, the utilization of arithmetic coding can reduce the mean squared error or increase the peak signal to noise ratio (PSNR) by 0.3 to 0.6 dB for the same rate or compressed file size and achieve results which are equal to or superior to any previously reported, regardless of complexity. Execution times are also reported to indicate the rapid speed of the encoding and decoding algorithms. The transmitted code or compressed image file is completely embedded, so that a single file for an image at a given code rate can be truncated at various points and decoded to give a series of reconstructed images at lower rates.

IV. CONCLUSION

The SPIHT algorithm has become the benchmark state-of-the-art algorithm for image compression. The SPIHT method is not a simple extension of traditional methods for image compression, and represents an important advance in the field.

In this paper, we have discussed the algorithm which operates through set partitioning in hierarchical trees (SPIHT) and accomplishes completely embedded coding. This SPIHT algorithm uses the principles of partial ordering by magnitude, set partitioning by significance of magnitudes with respect to a sequence of octavely decreasing thresholds, ordered bit plane transmission, and self-similarity across scale in an image wavelet transform. The realization of these principles in matched coding and decoding algorithms is more effective than in previous implementations of EZW coding. The image coding results in most cases surpass those reported previously on the same images, which use much more complex algorithms and do not possess the embedded coding property and precise rate control. Hence, this algorithm provides a heuristic approach to image compression which is much simpler and expected to provide good results.

REFERENCES

[1] J.M. Shapiro, "Embedded image coding using zerotrees of wavelets coefficients," IEEE Trans. Signal Processing, vol. 41, pp. 3445-3462, Dec. 1993.

[2] M. R.abbani, and P.W. Jones, Digital Image Compression Techniques, SPIE Opt. Eng. Press, Bellingham, Washington, 1991.

[3] R.A. DeVore, B. Jawerth, and B.J. Lucier, "Image compression through wavelet transform coding," IEEE Trans, inform. Theory, vol. 38, pp. 719-746, iVlarch 1992.

[4] E.H. Adelson, E. Simoncelli, and R. Hingorani, "Orthogonal pyramid transforms for image coding," Proc. SPIE, vol. 845 - Visual Comm. and Image Proc. 11, Cambridge, MA, pp. 50-58, Oct. 1987.

[5] M. Antonini, M. Barlaud, P. Mathieu, and 1. Daubechies, "Image coding using wavelet transform," IEEE Trans. Image Processing, vol. 1, pp. 205-220, April 1992.

[6] A. Said and W.A. Pearlman, "Image compression using the spatial-orientation tree," IEEE Int. Sym.p. on Circuits and Systems, Chicago, 1L, pp. 279-282, May, 1993.

[7] I.H.. Witten, R.M. Neal, and J.G. Cleary, "Arithmetic coding for data compression," Com-mun. ACM, vol. 30, pp. 520-540, June 1987.