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A Review of Image Compression based on Wavelet Transform Function and Structure Optimization Technique

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Abstract:- **The transmission of multimedia data such as image video and audio file take huge amount of time and memory. but For the increase the efficiency of transmission and storage image compression is required. In current research trend various image compression techniques or method are used such as JPEG-2000, RLZ, DCT, wavelet and other method. This method is very efficient in image compression, but the structures of image are not change so compression technique suffered from a problem of quality degradation. In this paper we give some review of latest trend of image compression**

Keywords:- **image compression, wavelet transform and optimization technique.**

I. INTRODUCTION

In recent years, the development and demand of multimedia product grows increasingly fast, contributing to insufficient bandwidth of network and storage of memory device. Therefore, the theory of data compression becomes more and more significant for reducing the data redundancy to save more hardware space and transmission bandwidth. In computer science and information theory, data compression or source coding is the process of encoding information using fewer bits or other information-bearing units than an unencoded representation. Compression is useful because it helps reduce the consumption of expensive resources such as hard disk space or transmission bandwidth. Image compression is an application of data compression that encodes the original image with few bits. The objective of image compression is to reduce the redundancy of the image and to store or transmit data in an efficient form. Recently, wavelet transforms have attracted considerable attention, especially with applications to image coding, due to their ability to provide attractive space-frequency resolution tradeoffs for natural images [3], [4]. In addition to conventional scalar (or vector) quantization strategies that are common in subband coding [5], the hierarchical wavelet image representation also allows improved quantization strategies for exploiting the spatial and frequency characteristics of wavelet coefficients (e.g., zerotree quantization [6]). In our previous work [1], a space-frequency quantization (SFQ) scheme was formulated via the joint application of zerotree quantization and scalar quantization within the wavelet framework. A rate-distortion based optimization of the two quantization modes in SFQ offers a performance that is among the best in the published image coding literature. The SFQ scheme may be viewed as a rate-distortion optimized variant of Shapiro's EZW coder [6]. Wavelet based zerotree image coding methods [21], [22] exploit the similarities across wavelet sub-bands by grouping coefficients belonging to sub-bands of different resolutions and encoding the group as a single codeword. The zerotree coding schemes are quite efficient in terms of both computational complexity and compression performance. Moreover, embedded (progressive) transmission (reconstruction), which is required in many applications, using zerotrees with successive approximation quantization (SAQ), is quite straightforward. Wavelet based methods, however, have a problem at low bit rates: while they perform well on images containing smooth regions and edges, they perform poorly on images with oscillatory patterns. The quantization of many low energy coefficients belonging to the high frequency sub-bands causes artificial smooth regions (smearing) in the areas of the image that contain rapid variations of intensity. Wavelet packets were invented [4] to pinpoint signal components present locally in the frequency domain. The nondyadic nature of a wavelet packet (WP) transform allows us to find an orthogonal basis adapted to the contents of given image and to the purpose of representation. However, there has not been as much research activity in wavelet packet image coding as in the area of wavelet image coding, due to its being computationally more expensive than the wavelet transform. in recent years. Among these algorithms, two coding techniques,i.e. set partitioning and context-modeling entropy coding, are proved to be very powerful. Derived from EZW [1], SPIHT [2] represents the most effective tree-structure set partitioning algorithm that exploits the self-similarities between coefficients across the hierarchical sub-bands. Though many researchers attribute its excellent efficiency to the great success of zerotree hypothesis, we deem that the intra-band dependencies and the energy distribution across different scales are the real reasons.Another branch of the set-partitioning technique is the block-structure based partitioning scheme, which utilizes energyclustering property within each sub-band. Many coding algorithms, such as SPECK [3] and QT-L [4], belong to this block-structure branch. Besides the set-partitioning coding scheme, contextmodeling entropy coding is another effective technique to exploit the strong statistical dependencies between wavelet coefficients. With carefully designed context models, EBCOT [5] achieves high compression efficiency, and has become the core algorithm of JPEG2000 [6] still image compression standard. While wavelet transform usually provides an efficient frequency representation for signals, its fixed space-frequency tiling does not always match the spectrum of input images. Wavelet packet (WP), which allows a large variety of frequency tiling, including the uniform subband decomposition and the usual dyadic decomposition, has been constructed in [7] to adapt the underlying wavelet bases to the frequency content of a signal. Since zerotree coding has achieved high efficiencies for wavelet subband coding, many efforts have been made to combine the zerotree quantization methods with the WP decomposition [8, 9]. However, due to the dyadic nature of wavelet subbands, definition of the zerotree structure is quite straightforward; but for the diverse subband structures of WP decomposition, it is difficult to define the parent-child relationships. Furthermore, even a compatible zerotree structure can be defined for arbitrary WP transforms, as Meyer et al did in [9], the probability of successful zerotree prediction in a WP decomposition is much lower than that in a wavelet decomposition. Therefore the failure predictions surely degrade final coding efficiency. The rest of paper is organized as follows. In Section II discuss related work in image compression. The Section III wavelet transforms. Section IV optimization technique .section V discuss objective of survey followed by a conclusion in Section VI.

II. RELATED WORK

In this section we discuss the related work about digital image compression in concern of transform function and some other technique for better compression process. Wavelet is transform function play important role in digital multimedia data. Thomas Stutz and PolytechNantes [5] describe the image compression on the basis of optimal selection of wavelet packet as rate-distortion optimal wavelet packet basis selection in JPEG2000 are presented and compared to more efficient wavelet packet basis selection schemes. Both isotropic and anisotropic wavelet packet bases are considered. For the first time, computationally efficient heuristics are compared to the best bases in the standardized coding framework of JPEG2000. Lei Chen , Chao Bei, YujiaZhai and Jing Wu[6] describe image compression based on the precompression algorithm as DWT-based compression scheme to efficiently and directly utilize the various properties of hyperspectral images, such as their statistic characteristics, spectral correlation, and spatial correlation, a new framework of DWT-based compression is proposed and a so-called precompression process is built and introduced into it. BahriyeAkay and DervisKaraboga[7] in wavelet transform, approximation and detail coefficients are extracted from the signal by filtering. Both approximation and detail coefficients are re-decomposed up to some level to increase frequency resolution. Once coefficients are generated, the optimum threshold values are determined to obtain the best reconstructed image, which can be considered as an optimization task. ZhenghuaShu ,Guodong Liu, Qing Xie, LvmingZeng and LixinGan [8]proposed a method of image coding algorithm based on a rate-distortion optimized wavelet-based contourlet packets (WBCP) decomposition and on a block-partitioning coding scheme which quantizes each subband separately is proposed. Alessandro J. S. Dutra[9] describe the wavelet coding for image compression of hyperspectral image as lossy compression algorithms which build on a state-of-the-art codec, the Set Partitioned Embedded Block Coder (SPECK), by incorporating a lattice vector quantizer codebook, therefore allowing it to process multiple samples at one time. GuoHui and Wang Yongxue[10] give a new method of compression on medical image. It is to decompose and reconstruct the medical image by wavelet packet. Before the construction the image, use neural network in place of other coding method to code the coefficients in the wavelet packet domain. By using the Kohonen's neural network algorithm, not only for its vector quantization feature, but also for its topological property. X. Z. Yao, S. C. Chan, Z. Y. Zhu, K. T. Ng and H. Y. Shum [11]describe image compression based on prioritized transmission and progressive rendering as an efficient algorithm for the compression, prioritized transmission and progressive rendering of circular light field (CLF) for ancient Chinese artifacts. It employs wavelet coder to achieve spatial scalability and divide the compressed data into a lower resolution base layer and an additional enhancement layer. Jing-Siang Wei, Zeng-Yao Lin, and Chian C. Ho [12]describe the slice group of unit H.264 flexible macro block ordering and embedding technique as Evolved from conventional Flexible Macro block Ordering (FMO) that is coded out of raster sequence in spatial domain, this paper presents Wavelet-domain slice group partition and unequal error protection for H.264/AVC video communication. HuseyinKusetogullari, Amir Yavariabdi, Mark S. Leeson and Evor L. Hines [13]describe the code flow optimization of bit in image coding for compression. multi-path optimization using genetic algorithm (GA) and rainbow network flow (RNF) for maximizing the received multiple description coding (MDCs) in a lossy network model is proposed The networkflow of multiple description codes (MDCs) is considered and the idea of routing as finding paths for a rainbow of colors (rainbow network flow or RNF) incorporated.

III. Wavelet Transform in Image Compression

Wavelet transform (WT) represents an image as a sum of wavelet functions (wavelets) with different locations and scales [17]. Any decomposition of an image into wavelets involves a pair of waveforms: one to represent the high frequencies corresponding to the detailed parts of an image (wavelet function ψ) and one for the low frequencies or smooth parts of an image (scaling function Ø). The Discrete wavelet transform (DWT) has gained wide popularity due to its excellent decorrelation property, many modern image and video compression systems embody the DWT as the transform stage. It is widely recognized that the 9/7 filters are among the best filters for DWT-based image compression. In fact, the JPEG2000 image coding standard employs the 9/7 filters as the default wavelet filters for lossy compression and 5/3 filters for lossless compression. The performance of a hardware implementation of the 9/7 filter bank (FB) depends on the accuracy with which filter coefficients are represented. Lossless image compression techniques find applications in fields such as medical imaging, preservation of artwork, remote sensing etc [16] . Day-by- day Discrete Wavelet Transform (DWT) is becoming more and more popular for digital image compression. Biorthogonal (5, 3) and (9, 7) filters have been chosen to be the standard filters used in the JPEG2000 codec standard. Discrete wavelet transform as reported by Zervas et al., there are three basic architectures for the two-dimensional DWT: level-by-level, line-based, and block-based architectures. In implementing the 2-D DWT, a recursive algorithm based on the line based architectures is used. The image to be transformed is stored in a 2-D array. Once all the elements in a row are obtained, the convolution is performed in that particular row [14]. The process of row-wise convolution will divide the given image into two parts with the number of rows in each part equal to half that of the image. This matrix is again subjected to a recursive line-based convolution, but this time column-wise [14]. The result will DWT coefficients corresponding to the image, with the approximation coefficient occupying the top-left quarter of the matrix, horizontal coefficients occupying the bottom-left quarter of the matrix, vertical coefficients occupying the top-right quarter of the matrix and the diagonal coefficients occupying the bottom-right quarter of the matrix[15]. After DWT was introduced, several codec algorithms were proposed to compress the transform coefficients as much as possible. Among them, Embedded Zerotree Wavelet (EZW), Set Partitioning In Hierarchical Trees (SPIHT) and Embedded Bock Coding with Optimized Truncation (EBCOT) are the most famous ones The embedded zero tree wavelet algorithm (EZW) is a simple, yet remarkably effective image compression algorithm, having the property that the bits in the bit stream are generated in top-right quarter of the matrix and the diagonal coefficients occupying the bottom-right quarter of the matrix. After DWT was introduced, several codec algorithms were proposed to compress the transform coefficients as much as possible. Among them, Embedded Zero tree Wavelet (EZW), Set Partitioning In Hierarchical Trees (SPIHT) and Embedded Bock Coding with Optimized Truncation (EBCOT) are the most famous ones. The embedded zerotree wavelet algorithm (EZW) is a simple, yet remarkably 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. The embedded code represents a sequence of binary decisions that distinguish an image from the ―null‖ image. 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 [16]. 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 bit stream. In addition to producing a fully embedded bit stream, EZW consistently produces compression results that are competitive with virtually all known compression algorithms on standard test images. Yet this performance is achieved with a technique that requires absolutely no training, no pre-stored tables or codebooks and requires no prior knowledge of the image source. The EZW algorithm is based on four key concepts: 1) A discrete wavelet transform or hierarchical sub band decomposition. 2) Prediction of the absence of significant information across scales by exploiting the self -similarity inherent in images. 3) Entropy-coded successive-approximation quantization, and 4) Universal lossless data compression which is achieved.

IV. OPTIMIZATION TECHNIQUE

In the optimization technique of compression, there is limited number of studies employing heuristics in quantization or thresholding of the coefficients. Moore introduced an approach based on genetic algorithm (GA) that evolves coefficients instead of wavelet transform [18]. An inverse wavelet transform is calculated by the coefficients produced by GA and then the compressed signals are generated. Mean square error (MSE) values of the compressed signals and the original signals in the set are used by GA to update the coefficients. Chen et al. used Particle Swarm Optimization (PSO) algorithm to find a global threshold and a step size to reach a target bit rate [19]. Kaur et al. jointly optimizes the best-basis selection, coefficient thresholding and quantizes selection within the minimum description length (MDL) framework to develop a wavelet packet image coder [8]. Ye et al. proposed a method based on PSO algorithm to enhance the quality of the compressed images [20]. Artificial Bee Colony (ABC) [5] algorithm is an optimization algorithm which simulates the foraging behavior of honey bees. The algorithm is a promising tool for optimizing various unconstrained and constrained optimization problems [21], [22]. In this paper, ABC algorithm is used to solve the compression problem which can be considered as multi-objective since there is a trade-off between high compression rate and high quality.

V. OBJECTIVE OF SURVEY

Uncompressed images normally require a large amount of storage capacity and transmission bandwidth. For example, a 24-bit true colour high-definition television (HDTV) image with size 1920*1080 needs approximately 6 megabytes (6M bytes) of storage space. On the other hand, various types of redundancy exist in images, such as temporal redundancy, spatial redundancy (or interpixel redundancy), coding redundancy, spectral redundancy and psycho visual redundancy. The primary goal of image compression is to minimize the number of bits required to represent the original images by reducing the redundancy in images, while still meeting the User defined quality requirements. The core issue in image compression is to design efficient and reactive compression schemes. The problem is even more severe when a block crosses an image boundary. Here, they actually destroy valuable image information and the infamous blocky artifacts of the JPEG compression appear. A logical consequence in improving such algorithms is to be less blind. Therefore one uses semantic image information, the so called image features, like edges or corners, to decide which are the vital informationcontents of the image one wants to preserve in the compression step.The problem of image compression based on wavelet packet is mentioned in following step. The parent–child relationships of tree structures are difficult to define and the probability of zerotrees are greatly reduced in the Wavelet Packet.

Complex quantization process of zerotree.

Bad PSNR in images of rich textures and higher visual quality in the region of texture area.

Difficult to design adaptable size of coded blocks according to the level of wavelet packet decomposition

VI. CONCLUSION AND FUTURE WORK

In this paper we reviewed and summarized the characteristics of image compression, related method of image compression, principles behind compression, different classes of compression techniques and various image compression algorithms based on Wavelet, JPEG/ DCT, VQ, and Fractal approaches. Image Compression benchmark is planned to advance uniform image coding systems to serve application into the next millennium. It has to provide a set of features vital to many high-end and emerging image applications by taking advantage of new modern technology. Specifically, the new standard will address areas where current standards fail to produce the best quality or routine. It will also provide capabilities to markets that now do not use compression

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