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AN APPROACH ON PZW CODING TECHNIQUE USING SPHIT AND EZW CODING TECHNIQUE

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ABSTRACT

There has been a serious trend to convert conventional analog images to digitized images. The volume of digitized image being very high, will considerably slowdown the transmission and storage of such images. Therefore there is strong need of compression of the images by extracting the visible elements which are encoded and transmitted. This will substantially reduce the quantity of data to be stored and transmitted. Compression can be achieved by transforming the data and projecting it on the basis of functions and then encoding the transform. Wavelet coding has received considerable attention for image compression applications because it can hierarchically decompose an input image into a series of successfully low resolution approximation images and their associated detailed images at each level. When an image is subjected to n-level decomposition using DWT (Discrete Wavelet Transforms), the nth level will correspond to the lowest frequency sub-band and to the lowest resolution. When an image is decomposed using wavelet transforms one will get approximation and detailed images.we propose the EZW and SPIHT coding and ARQ (Automatic retransmission request) and FEC (Forward error correction) techniques and finally PZW (Packetizable Zero Tree Wavelet) coding techniques by modifying the EZW/SPIHT coding algorithms.

KEYWORDS: DWT, EZW, SPIHT and PZW

INTRODUCTION

In the past few years, there has been a tremendous increase in the need for the amount of information stored in the form of images especially from Remote Sensing Satellites, Weather Satellites and Medical images. These images must be made easily accessible to the individual users, who would like to make use of the images for various applications. There are many issues involved in making large amounts of information accessible to remote users. Recently there has been a serious trend to convert conventional analog images to digitized images. The volume of digitized image being very high, will considerably slowdown the transmission and storage of such images. Therefore there is strong need of compression of the images by extracting the visible elements which are encoded and transmitted. This will substantially reduce the quantity of data to be stored and transmitted.

Compression can be achieved by transforming the data and projecting it on the basis of functions and then encoding the transform. Wavelet coding has received considerable attention for image compression applications because it can hierarchically decompose an input image into a series of successfully low resolution approximation images and their associated detailed images at each level. The approximation and detailed images contain the information needed to reconstruct the approximation image at the next higher resolution level. Efficient image coding is achieved by allocating bandwidth according to the relative importance of information in the approximation and detailed images and then applying the quantization to the transformed data value.

When an image is subjected to n-level decomposition using DWT (Discrete Wavelet Transforms), the nth level will correspond to the lowest frequency sub-band and to the lowest resolution. When an image is decomposed using wavelet transforms one will get approximation and detailed images. The wavelet coefficients in the detail images will have very low values. Consequently most of them, based on a threshold value can be quantized to zero without affecting the perceived quality of the image. All wavelet based compression techniques take advantage of this phenomenon. If the DWT coefficients at a particular level have a small magnitude, then it is expected that DWT coefficients at lower levels corresponding to same spatial position would have smaller values. There are spatial self- similarities across sub-bands. The EZW coding exploits spatial self-similarities to give excellent compression ratios. And we propose SPIHT (Set Partitioning in Hierarchical Trees) coding techniques, the coefficients which has more information is coded first, so it produces an embedded bit stream with extremely fast execution. The transmitted code can be truncated at any point and decoded to give a series of a reconstructed image at low rates. In the EZW coding lot of information is transmitted to declare an entire spatial orientation tree to be insignificant and represent all the coefficients in it with a 2zero tree root label. The SPHIT algorithm uses the partitioning of trees in a manner that tends to keep insignificant coefficients together in larger sub-sets. These partitioning decisions provide a significance map encoding that is more efficient than EZW coding.

The EZW and SPIHT coding provides the high performance and low complexity image compression. The EZW and SPIHT coding are remarkably effective image compression algorithms having the property that the bits in the compressed bit stream are generated in the order of importance yielding a fully embedded code. The major drawback of EZW and SPIHT coding technique is its susceptibility to bit errors. Even a single bit error may lead to the derailment of the decoder. This problem can be resolved by ARQ (Automatic retransmission request) and FEC (Forward error correction) techniques. But these techniques could introduce delay in transmission and needs extra bits for error detection and correction to overcome these problems.

We have also propose PZW (Packetizable Zero Tree Wavelet) coding techniques by modifying the EZW/SPIHT coding algorithms such that the resultant bit stream can be arranged into fixed length packet and make them independently decodable. The error occurring in one packet should not affect the other packets. This technique is capable of withstanding the packet erasure or loss without the use of the ARQ and FEC techniques.

RELATED WORK

The neighboring pixels of most natural images are highly correlated and thus contain lot of redundant information. A less correlated representation of the image is the result of any compression algorithm. The main task of image compression algorithms is reduction of redundant and irrelevant information. In the present scenario, various methods of compressing still images exist. In any data compression scheme, three basic steps are involved: Transformation, Quantization and Encoding.

Transformation

In image compression, transform is indented to de-correlate the input pixels. Selection of proper transform is one of the important issues in image compression schemes. The transform should be selected in such a way that it reduces the size of the resultant data set as compared to the source data set. Few transformations reduce the numerical size of the data items that allow them to represent by fewer binary bits. The technical name given to these methods of transformation is mapping Some mathematical transformations have been invented for the sole purpose of data compression. These include the Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT) and Wavelet Transforms (WT).

Quantization

Let X be a (possibly continuous) set, and K be a discrete set. Let Q and D be mappings Q : X ! K and D : K ! X. Q and D are such that kx D(Q(x))k _ kx D(d)k 8 d 2 K Applying Q to some x 2 X is called **quantization**, and Q(x) is the quantized value of x. Likewise, applying D to some k 2 K is called **dequantization** and D(k) is the dequantized value of k. In applications, X is often a continuous space such as R, and K a small set of integers (e.g. 0 . . . 2N1 for N on the order of 10). Clearly Q is not invertible. In some sense, D is an approximate inverse. of Q.

The procedure of approximating the continuous set of values in the image data with a finite, preferably small set of values is called quantization. The original data is the input to a quantizes and the output is always one among a limited number of levels. The quantization step may also be followed by the process of threshold. Each sample is scaled by a quantization factor in the process of quantization, whereas the samples are eliminated if the value of the sample is less than the defined threshold value, in the process of thresholding.

Encoding

Encoding process reduces the overall number of bits required to represent the image. An entropy encoder compresses the quantized values further to give better overall compression. This process removes the redundancy in the form of repetitive bit patterns at the output of the quantizer. It uses a model to precisely determine the probabilities for each quantized value and produces a suitable code based on these probabilities so that the resultant output code stream will be smaller than the input. Commonly used entropy coders are the Huffman encoder and the Arithmetic encoder.

METHODLOGY

We propose the EZW and SPIHT coding and ARQ (Automatic retransmission request) and FEC (Forward error correction) techniques and finally PZW (Packetizable Zero Tree Wavelet) coding techniques by modifying the EZW / SPIHT coding algorithms.

Wavelets Codecs for Image Compression

Wavelet-based coding provides substantial improvements in picture quality at higher compression ratios. Furthermore, at higher compression ratios, wavelet coding methods degrade much more gracefully than the block-DCT methods. Since the wavelet basis consists of functions both with short support and long support for high frequencies and for low frequencies respectively, smooth areas of the image may be represented with very few bits, and detail can be added where ever required. Their superior energy compaction properties and correspondence with the human visual system have made, wavelet compression methods produce subjective results. Due to the many advantages, wavelet based compression algorithms have paved way for the for the new JPEG-2000 standard. Traditional DCT & sub band coding: trends “obscure” anomalies that carry info E.g., edges get spread, yielding many non-zero coefficients to be coded.

Wavelets are better at localizing edges and other anomalies that Yields a few non-zero coefficients & many zero coefficients and Difficulty: telling the decoder “where” the few non-zero’s. Natural images in general have a low pass spectrum. The wavelet coefficients will, on average, be smaller in the higher sub bands than in the lower sub bands. Large wavelet coefficients are more important than smaller wavelet coefficients. Significance map (SM): binary array indicating location of zero/non-zero coefficients typically requires a large fraction of bit budget to specify the SM. Wavelets provide a structure (zero trees) to the SM that yields efficient coding.

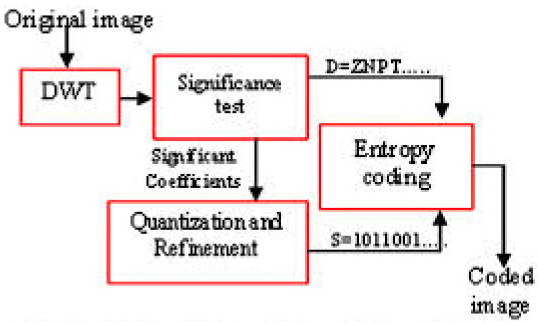

Figure 1: EZW/SPIHT Coding

A number of novel and sophisticated wavelet-based schemes for image compression have been developed and implemented over the past few years. Some of the most popular schemes are discussed in the paper. These include Embedded Zero Tree Wavelet (EZW), Set-Partitioning in Hierarchical.

Trees (SPIHT), ARQ (Automatic retransmission request) and FEC (Forward error correction) techniques and finally PZW (Packetizable Zero Tree Wavelet) coding techniques by modifying the EZW / SPIHT coding algorithms.

The EZW and SPIHT coders keep quite a bit of state in the zero tree structures and significance sets. In effect, this constitutes a model for the data that is updated during the coding process. One interesting side-effect of this approach is that entropy coding (with an adaptive arithmetic coder) the bit stream after the SPIHT algorithm resulted in only a minor gain. It is natural to ask if this is due to the algorithm having assumed some of the role of the entropy coder.

Hybrid Codec

One of the characteristics of zero tree coders and similarly, schemes like the one presented are that many small coefficients may be approximated as zero, especially at low bit-rates. Coefficients at high levels in the tree will be small due to the decay rate of the coefficient trees, but they need not be zero. From these two points a new hybrid coder was conceived. The idea is to use an IFSW approach starting at a high level parent to get a very rough approximation of the image which includes many high frequency coefficients.

Zero Tree Coders

After the wavelet transform has been performed, most of a signal's energy is present in relatively few coefficients. In compressing the signal, the idea is to encode these coefficients and ignore the rest. One approach is to apply a magnitude threshold: every coefficient smaller than some value is considered to be zero. The problem now is to identify and encode the small number of non-zero coefficients. Shapiro tackled this problem by identifying zero trees, that is, sub trees rooted at some position in the coefficient tree where the root and all children are zero. In a sparsely populated coefficient tree, identifying these zero trees allows efficient identification of the non-zero coefficients. Of course this process can be repeated for several thresholds, allowing progressive improvement in the approximation. A key feature of these approaches is that they are embedded coders: the decoder does not need all of the output of the encoder in order to decode, rather, it may decode bits as they are read from the encoder.

Every wavelet coefficient at a given scale can be related to a set of coefficients at the next finer scale of similar orientation.Zerotree root (ZTR) is a low scale “zero-valued” coefficient for which all the related higher-scale coefficients are also “zero-valued”. Specifying a ZTR allows the decoder to “track down” and zero out all the related higher-scale coefficients

EZW (Embedded Zero Trees Wavelet) Coding

The EZW coding for image compression is a simple, remarkably effective algorithm of this kind introduced by Shapiro EZW coding exploits the multi resolution properties of the wavelet transforms to give a computationally simple algorithm with better performance compared to other existing wavelet transforms. Embedded encoding is also called progressive encoding.

The EZW algorithm is based on four key concepts

- Discrete wavelet transform (hierarchical sub band decomp)
- Prediction of the absence of significant information across scales by exploiting the self-similarity inherent in images
- Entropy-coded successive-approximation quantization
- “Universal” lossless data compression which is achieved via Adaptive arithmetic coding.

The Embedded Zero tree Wavelet encoder is based on progressive coding to compress an image into a bit stream with increasing accuracy. This means that as more bits are added to the stream, the decoded image The encoding method used by the EZW is the bit plane encoding. Zero trees are a concept that allows for a concise encoding of the positions of significant values that result during the embedded coding process. The EZW encoding is based on two main observations:

- When the wavelet transformation of an image is taken, the energy in the sub bands decreases as the scale decreases (low scale means high resolution). So on an average, the wavelet coefficients will be smaller in the higher sub bands than in the lower sub bands.
- Large wavelet coefficients are more vital than the small ones.

EZW Encoding

An EZW encoder is an encoder specially designed to use with wavelet transforms, which explains why it has the word wavelet in its name. The EZW encoder 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. It is also similar to the representation of a number like p. Every digit we add increases the accuracy of the number, but we can stop at any accuracy we like. Progressive encoding is also known as embedded encoding, which explains the E in EZW.Coding an image using the EZW scheme, together with some optimizations results in a remarkably effective image compressor with the property that the compressed data stream can have *any* bit rate desired. *Any* bit rate is only possible if there is information loss somewhere so that the compressor is lossy. However, lossless compression is also possible with an EZW encoder, but of course with less spectacular results.

A very direct approach is to simply transmit the values of the coefficients in decreasing order, but this is not very efficient. This way a lot of bits are spend on the coefficient values and we do not use the fact that we know that the coefficients are in decreasing order. A better approach is to use a threshold and only signal to the decoder if the values are larger or smaller than the threshold. If we also transmit the threshold to the decoder, it can reconstruct already quite a lot. To arrive at a perfect reconstruction we repeat the process after lowering the threshold, until the threshold has become smaller than the smallest coefficient we wanted to transmit. We can make this process much more efficient by subtracting the threshold from the values that were larger than the threshold. This results in a bit stream with increasing accuracy and which can be perfectly reconstructed by the decoder. If we use a predetermined sequence of thresholds then we do not have to transmit them to the decoder and thus save us some bandwidth. If the predetermined sequence is a sequence of powers of two it is called bit plane coding since the thresholds in this case correspond to the bits in the binary representation of the coefficients. Encoding does not really compress anything, it only reorders wavelet coefficients in such a way that they can be compressed very efficiently. An EZW encoder should therefore always be followed by a symbol encoder, for instance an arithmetic encoder

The SPIHT (Set Partitioning in Hierarchical Trees Coding)

The SPIHT coding is an improved version of the EZW algorithm that achieves higher compression and better performance than EZW.

SPIHT is expanded as Set Partitioning in Hierarchical Trees. The term Hierarchical Trees.

Refers to the quad trees that are defined in the discussion of EZW. Set Partitioning refers to the way these quad trees divide up and partition the wavelet transform values at a given threshold. By a careful analysis of this partitioning of transform values, Said and Pearlman were able to develop the EZW algorithm, considerably increasing its compressive power.

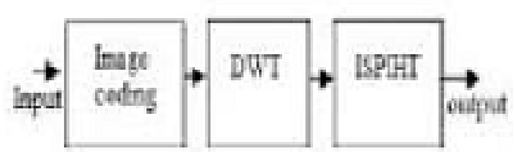

Figure 2: SPIHT Coding

SPIHT algorithm produces an embedded bit stream from which the best reconstructed images with minimal mean square error can be extracted at various bit rates. Some of the best results like highest.

The main features of SPIHT coding are:

- Good quality reconstructed images, high PSNR, especially for colour images
- Optimized for progressive image transmission
- Produces a fully embedded coded file
- Simple quantization algorithm
- Fast coding/decoding (near symmetric)
- Has wide applications, fully adaptive
- Can be used for lossless compression

SPIHT represents a small "revolution" in image compression because it broke the trend to more complex (in both the theoretical and the computational senses) compression schemes. While researchers had been trying to improve previous schemes for image coding using very sophisticated vector quantization, SPIHT achieved superior results using the simplest method: uniform scalar quantization. Thus, it is much easier to design fast SPIHT codec's. SPIHT codes the individual bits of the image wavelet transform coefficients following a bit-plane sequence. Thus, it is capable of recovering the image perfectly (every single bit of it) by coding all bits of the transform. However, the wavelet transform yields perfect reconstruction only if its numbers are stored as infinite-precision numbers. In practice it is frequently possible to recover the image perfectly using rounding after recovery, but this is not the most efficient approach. SPIHT has also been tested for some less usual purposes, like the compression of elevation maps, scientific data, and others.

Embedded Coding in SPHIT

An algorithm is said to provide an embedded bit stream if one can extract a smaller file with a given characteristic that would have the same characteristic if produced directly by the same algorithm. Pure rate-embedded algorithms have granularity at the bit level. A rate scalable algorithm refers to similar properties, regardless of the granularity of the embedding. A rate embedded coder allows progressive encoding from lossy to purely lossless reconstruction, when the filters map integers from the image domain to integers in the transform domain.

SPIHT employs a two-dimensional pyramidal DWT to generate hierarchical wavelet sub bands. A simple scalar dead zone quantize for the DWT coefficients is used for SPIHT. Quantization is performed in two passes, the sorting pass and the refinement pass. The sorting pass identifies the significant coefficients with respect to a threshold T and gives their sign. The identified significant coefficients are recorded in the list of significant pixels (LSP). On the other hand, insignificant spatial-orientation trees are stored in the list of insignificant sets (LIS), previously recognized as zero trees in EZW. The other isolated insignificant coefficients are kept in the list of insignificant pixels (LIP). One of the major improvements of SPIHT over EZW is the more effective and flexible identification of zero trees to increase the chance of forming zero trees. The refinement pass narrows the quantization cell size to T for those coefficients having magnitude greater than 2T. The sorting pass and refinement pass are iterated with halved threshold in the next iteration.

ARQ (Automatic Retransmission Request) and FEC (Forward Error Correction) Techniques

Various problems occur in packet switched networks.

Inadequate buffer space at network switches may cause packets to be dropped during periods of congestion (packet erasure). Packets may be received with corrupted bits; and the decoder might make use of the erroneous data in the packet. Error detection coding enables the decoder to discard corrupted packet, and retransmission protocols (ARQ) allow the decoder to request that missing or discarded packets be sent again. ARQ schemes introduce delay. Forward error correction (FEC) techniques allow the decoder to correct a certain number of errors, but they reduce the compression achievable because extra bits are added. Error concealment techniques seek to approximate (for example, by interpolation) the data from an erased packet. The wavelet zero tree compression and packetization method described in this to packet erasures without the use of FEC or ARQ schemes.

PZW (Packetizable Zero Tree Wavelet) Coding Technique

PZW (Packetizable Zero Tree Wavelet) coding techniques by modifying the EZW / SPIHT coding algorithms such that the resultant bit stream can be arranged into fixed length packet and make them independently decodable. The error occurring in one packet should not affect the other packets. This technique is capable of withstanding the packet erasure or loss without the use of the ARQ and FEC techniques. Important wavelet coefficients are duplicated, and packetization is achieved by independent coding each of the directional wavelet branches. When a data packet is lost, its damage will be restricted to one directional component of a local area and the essential information of the packet may be recovered from correctly received packets.Packetization can be classified into two types, fixed-size and variable-size. The packetizable zero tree wavelet (PZW) packetization scheme and its optimization version (optimal packetization).

ENCODING/DECODING SPEED

The SPIHT process represents a very effective form of entropy-coding. This is shown by the demo programs using two forms of coding: binary-uncoded (extremely simple) and context-based adaptive arithmetic coded (sophisticated). Surprisingly, the difference in compression is small, showing that it is not necessary to use slow methods. A fast version using Huffman codes was also successfully tested, but it is not publicly available. Straightforward consequence of the compression simplicity is the greater coding/decoding speed. The SPIHT algorithm is nearly symmetric, i.e., the time to encode is nearly equal to the time to decode. (Complex compression algorithms tend to have encoding times much larger than the decoding times.) SPIHT belongs to the next generation of wavelet encoders, employing more sophisticated coding. In fact, SPIHT exploits the properties of the wavelet-transformed images to increase its efficiency.

RESULTS

SPIHT in compression is attributed to the formation of zero trees and the use of variable-length codes. However, the coded images have fragile visual quality when transmitted across an unreliable link because erroneous data usually causes severe error propagation. For a visual communication with no feedback mechanism, error control can be performed in three ways: 1) forward error correction (FEC), 2) error-resilient coding at encoders, and 3) error concealment at decoders. Many of these techniques have been tailored to protect SPIHT-coded images. Proposed a concatenated FEC scheme and a cyclic redundancy check (CRC) code as the outer code. 4) Divided the wavelet coefficients into disjoint trees for error isolation and interleaved the generated bit stream to produce scalable data.

Proposed separating low-frequency sub bands with high-frequency sub bands and applied adaptive packetization for better error resilience.

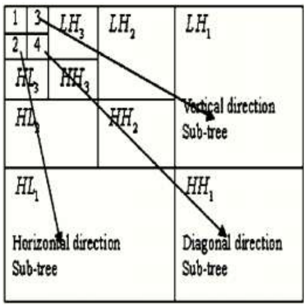

Figure 3: Wavelet Sub Tree

The following images shows various compressed images with different encoding techniques.

Figure 4: Original Image of Lena

Figure 5: Original Image of Baboon

Figure 6: Compression with Wavelet Zero Tree Image

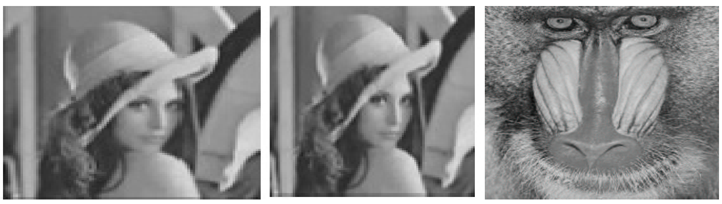

Figure 7: SPHIT Image, PZW Compressed Image

Figure 8: PZW with SPHIT Image

CONCLUSIONS

SPHIT algorithm uses the partitioning of trees in a manner that tends to keep insignificant coefficients together in larger sub-sets. The EZW and SPIHT coding provides the high performance and low complexity image compression and finally PZW (Packetizable Zero Tree Wavelet) coding techniques by modifying the EZW / SPIHT coding algorithms such that the resultant bit stream can be arranged into fixed length packet and make them independently decodable. We consider a new error-control framework for SPIHT-coded images sent across a memory less bit-error-free but packet-lossy link. In SPIHT, the coefficients of the wavelet transform are grouped into spatial orientation trees, that is, linked according to spatial orientation in sub bands across scales.

FUTURE SCOPE

EZW Employs progressive and embedded Transmission and Uses zero tree concept, predefined scanning order and Good results without pre-stored tables, Transmission of coefficient position is missing, No real compression Followed by arithmetic encoder

SPHIT is widely used high PSNR values for given CRs for variety of images and as Quad- tree or hierarchical trees are set. It as only implicitly locates position of significant coefficients and as More memory requirements that enables Suits variety of natural images and also Superior to JPEG in perceptual image quality and PSNR

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