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Image Compression using coding of wavelet coefficients

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ABSTRACT

The objective of this paper is to implement the wavelet based SPIHT image compression algorithm on different images. SPIHT is more efficient and provide a better quality in the image. In compression, wavelets have shown a good flexibility to variety of data. This paper focuses important feature of wavelet transform in the compression of still images including the extent to which the quality of the image degraded by the process of wavelet compression and decompression. It is successfully used in many applications like medical imaging, teleconferencing etc .

Keywords: Discrete wavelet transform, Compression ratio, PSNR.

I.INTRODUCTION

Now a days, compressing the digital images is necessary in order to store them and simplify their transmission. Wavelet-based coding provides substantial improvements in image quality at higher compression ratios. Over the past few years, several wavelet based Image Compression algorithms have been developed, such as Shapiro's Embedded Zero tree Wavelet compression (EZW) algorithm [1], Said and Pearlman's Set Partitioning in Hierarchical Trees (SPIHT) algorithm [2], and Taubman's Embedded Block Coding with Optimized Truncation (EBCOT) algorithm [3]. The purpose of compression is to code the image data into a compact form, minimizing both the number of bits in the representation, and the distortion caused by the compression. Here for compressing these large size image we used the discrete wavelet transforms[4].

1.1 Overview of Image Compression:

A four different algorithms were proposed in the literature. These algorithms are mainly divided into zero tree and zero block methods. Though both of the algorithms provide embedded coding and good compression efficiencies, zero tree algorithms were most popular in the literature, after which the zero block algorithms found their significance. The general idea of tree based algorithms is explained as follows. At low bit rates (i.e., high compression ratios) most of the coefficients produced by a sub band transform (such as the wavelet transform) will be zero, or very close to zero. This occurs because "real world" images tend to contain mostly low frequency information (highly) correlated). However some high frequency information does occur (such as edges in the image). This is particularly important in terms of human perception of the image quality, and thus must be represented accurately in any high quality coding scheme. By considering the transformed coefficients as a tree (or trees) with the lowest frequency coefficients at the root node and with the children of each tree node being the spatially related coefficients in the next higher frequency sub band, there is a high probability that one or more sub trees will consist entirely of coefficients which are zero or nearly zero, such sub trees are called zero trees. In zero tree based image compression schemes such as Embedded Zero tree Wavelet coding (EZW) [1] and Set Partitioning in Hierarchical Trees (SPIHT) [3], the intent is to use the statistical properties of the trees in order to efficiently code the locations of the significant coefficients. Since most of the coefficients will be zero or close to zero, the spatial locations of the significant coefficients make up a large portion of the total size of a typical compressed image. These algorithms make use of the relation among different sub bands existing in the same spatial orientation of an image. Since the image is transformed using DWT, the relation among the neighboring pixels of the image is preserved in the higher and higher sub bands. These are called the intra sub band correlations existing within each sub band. For the zero tree algorithms don't take care of these intra sub band correlations of an image sub band.

1.2 Key Concept of Image Compression

The key concepts of the compression are irrelevancy and redundancy reduction. Removing duplication from the original image is carried by redundancy reduction whereas the irrelevancy reduction omits the part of the signal which cannot be noticed by the signal receivers like Human Visual System [5]. The three kinds of redundancy are as follows a) Spatial Redundancy or correlation between neighboring pixel values, b) Spectral Redundancy or correlation between different color planes or spectral bands, c) Temporal Redundancy or correlation between adjacent frames in a sequence of images (in video applications). The image compression research aims at reducing the number of bits needed to represent an image by removing the spatial and spectral redundancies as much as possible [4].

1.3 Image Compression Types

Basically there are two types of Image Compression techniques such as:

1.3.1 Lossy Image compression

Lossy techniques cause image quality degradation in each Compression/decompression 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) [7]-[8].

1.3.2 Lossless Image Compression

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 [7].

Lossless coding guarantees that the decompressed image is identical to the image before compression. This is an important requirement for some application domains like 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 executable. Lossless compression algorithms can be used to squeeze down images and then restore them again for viewing completely unchanged [7].

II.LITERATURE SURVEY

Wavelet based image compression has obtained much popularity because of their overlapping nature which minimizes the blocking artifacts and multi-resolution character, results the high quality reconstructed images. Wavelet based schemes provides substantial improvements in picture quality at higher compression ratios. Also, at higher compression ratios, wavelet coding methods degrade much more gracefully than the DCT method [9]. Wavelet based compression schemes allow the combination of various compression methods into one and hence, a compression ratio of up to 300:1 is achievable. Various novel and classy wavelet based techniques for image compression have been developed and implemented over the past few years. These include Embedded Zero Tree Wavelet (EZW), Set-Partitioning in Hierarchical Trees (SPIHT), Wavelet Difference Reduction (WDR) and Adaptively Scanned Wavelet Difference Reduction (ASWDR), Spatial-orientation tree wavelet (STW) etc.

2.1 Embedded Zero tree wavelet-based image coding:

EZW coding involves the coding of the position of those wavelet coefficients that will be transmitted as anon-zero value. A wavelet coefficient, x is said to be insignificant with respect to a given threshold T if $|x| < T$. However, if $|x| \geq T$, then the coefficient is said to be significant with respect to T. If a wavelet coefficient at a higher scale is insignificant with respect to a given threshold T, then all the wavelet coefficients of the same orientation in the same spatial location at the lower scales are likely to be insignificant with respect to T [10]. In addition to produces compression results that are competitive with virtually all known compression algorithm on standards test images [11].

2.2 Set Partitioning into Hierarchical Trees

On the opposing, Said and Pearlman's SPIHT, rooted from EZW, gives the best result i.e. higher PSNR values for given compression ratios for a wide variety of images.It is probably the most widely used wavelet based image compression algorithm. The term hierarchical trees refers to the quad-trees that we defined in our discussion of ezw. Set partitioning refers to the way these quad-trees divide up, partition, and the wavelet transform values at a given threshold [11]. SPIHT is simply utilized in secure rate or variable rate transmission applications. With whole number DWT, SPIHT can even be utilized in lossless compression [12].

Although, SPIHT is well known for its simplicity and efficiency, it requires a large amount of memory to maintain three lists that are used for storing the coordinates of wavelet coefficients and tree sets in the coding and decoding processes. A great number of operations to manipulate the memory are also required in the codec scheme, which greatly reduces the speed of coding procedure. This becomes a big drawback for realizing the algorithm on hardware platform in real-time and low memory applications. So a high-speed and low memory image compression algorithm is

Desired [13].

2.3 Wavelet difference reduction (WDR) algorithm

One of the defects of SPIHT is that it only implicitly locates the position of significant coefficients. This makes it difficult to perform operations, such as region selection on compressed data, which depend on the exact position of significant transform values. By region selection, also known as region of interest (ROI), which means selecting a portion of a compressed image, which requires increased resolution. Compressed data operations are possible with the Wavelet

Difference Reduction (WDR) algorithm of Tian and Wells [14]. The term difference reduction refers to the way in which WDR encodes the locations of significant wavelet transform values. In WDR, the output from the significance pass consists of the signs of significant values along with sequences of bits which concisely describe the precise locations of significant values [15].

2.4 Adaptively Scanned Wavelet difference reduction (ASWDR) algorithm

One of the most recent image compression algorithms is the Adaptively Scanned Wavelet Difference Reduction (ASWDR) algorithm of Walker. ASWDR adapts the scanning order so as to predict locations of new significant values with region of interest capability.. If a prediction is correct, then the output specifying that location will just be the sign of the new significant value the reduced binary expansion of the number of steps will be empty. Therefore a good prediction scheme will significantly reduce the coding output of WDR. The scanning order of ASWDR dynamically adapts to the locations of edge details in an image, and this enhances the resolution of these edges in ASWDR compressed images and simple generalization of the WDR by improving the features like low complexity, region of interest capability, embeddedness and progressive PSNR[15]-[16].

III.PROBLEM IDENTIFICATION

The drawback of using an Image Compression algorithm like EZW, ASWDR WDR are: It transforms the image sub-band by sub-band. It produces less PSNR. The Compression ratio is very low. The Image quality is low as compared to the SPIHT algorithm. The WDR is applicable to only that image that are already compressed. It is applicable to only small size of the images. The existing is very time consuming because it compresses only those images that are already compressed. Sometimes this operation is not possible because it compresses that image exactly at half threshold.

IV.PROPOSED METHODOLOGY

1.1 Introduction to Wavelet

The fundamental set up behind wavelets is to analyze in line with the size. Indeed, some researchers among the ripple field feel that, by victimization wavelets, one is adopting a whole new outlook or perspective method information. Wavelets unit functions that satisfy positive mathematical wants and unit utilized in representing

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info or completely different functions. It is simpler to explain a basis function if it moves out of the area of analog (functions) and into the realm of digital (vectors) (*). Every two-dimensional vector (x, y) is a combination of the vector (1, 0) and (0, 1). These two vectors are the basis vectors for (x, y)[9].

1.2 Discrete Wavelet Transform

In Lossy image compression, Discrete Cosine Transform (DCT) is the core of JPEG international standards and is one of the most grown-up developed compression algorithms. For 1 0: 1 less than compression ratio, the DCT based JPEG image compression will not have a significant effect on geometry by using ,"Blocking artifacts" and the edge effects are produced under the large compression ratio. A good solution to this problem is the use of "wavelet". So from the last two decades for "Image Analysis and coding", DWT has become an important tool [7]-[8].Wavelet transform provides a compact multi-resolution representation of the image It has excellent energy compaction property which suitable for exploiting redundancy in an image to achieve compression. DWT can be implemented using two-channel wavelet filter bank in a recursive fashion. For an image, 2D-DWT is calculated using a separable approach. Input image is first scanned in the horizontal direction and passed through low pass and high pass decomposition filters producing low-frequency and high-frequency data in horizontal direction. The outputted data then scanned in a vertical direction and again these filters are applied separately to generate different frequency sub-bands. The transform generates sub-bands LL, LH, HL and HH each with one-fourth the size of the original image [17]. Most of the energy is concentrated in low-frequency sub band LL, whereas higher frequency sub-bands LH, HL and HH contain detailed information of the image in vertical, horizontal and diagonal directions, respectively. For high-level decomposition, DWT can be applied again to the LL sub-band recursively in a similar way to further compact energy into fewer low-frequency coefficients [18]. After DWT, the decomposed data resembles a tree structure with different scales. A coefficient at a coarser scale in wavelet tree is called a parent, whereas coefficients of the next finer scale at the same orientation are termed as children. When children of all the finer scales at the same orientation grouped together, they are known as descendants. A parent contains four children at its next level, with the exception at the highest level where a parent only contains three children and at the lowest level sub-bands has no children. A three-level wavelet decomposition of a block into sub-band is illustrated in the figure 1.

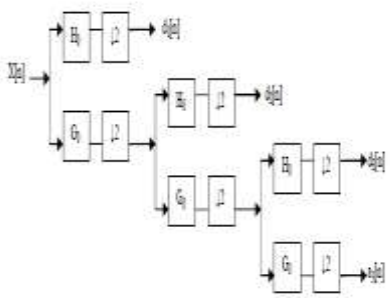

Fig 1.Three-level wavelet decomposition tree

V.EXPERIMENTAL RESULT

Based on the review of images its compression ratio, the quality of the image is known in terms of peak signal to noise ratio, bits per pixel and the time to execute the algorithm is calculated. Our results illustrated that we obtained the higher compression ratio for pears and Lena images. It is also coupled with the power of multi resolution analysis, wavelet based coders facilitate progressive transmission of images there by allowing variable bit rates. We also observe that Hanuman and Peppers images we get the higher PSNR value.

Table 1.Perofrmance Metric of various images

Image Name	Peak Signal to Noise Ratio	Time(Sec)	Compression Ratio	Bits Per Pixel
Pears	41.43	144.97	12	0.26
Hanuman	44.47	83.86	2.5	0.23
Lena	34.56	149.13	18.55	0.3
Peppers	48.25	111.41	7	0.8
Shree	41.98	116.55	4.06	1
Tours	33.56	148.67	20	0.79

VI.CONCLUSION

To identify the best wavelet for compressing color images, different Daubechies wavelet were used. The initial results show that different varied coding performance. Coding performance refers to Peak Signal-to-Noise Ratio (PSNR), the Compression Ratio (CR). To explore and understand how the various image features affect the coding performance, Greyscale image feature analysis is being employed initially as there is limited data on coding performance measures for color images. This will allow certain quantitative and qualitative comparisons to be made with the SPIHT algorithm.

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