Analysis of Wavelet Transform for Image Compression Using SPITH Algorithm

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Abstract -Last few years there has been astronomical increase in the usage of computers. In digital cameras, one of the most common uses has been the storage, manipulation, and transfer of digital images. Image compression is one of the important applications in data compression on its image. Image data requires huge amount of disk space and large bandwidths for transmission.In multimedia application, most of the images are in color and color images contain more data redundancy and require a huge amount of storage space. This project presents a new approach for compression of color images and gray scale using SPIHT algorithm along with wavelet transform. In this project we produce a new technique as adaptive lifting DWT. An Adaptive Lifting DWT that locally adapts the filtering directions to image content based on directional lifting. This technique using the new algorithm that detects all the blocks in a given image to decide whether the block is homogenous or heterogeneous block. For homogeneous block, the simple Discrete Wavelet Transform (DWT) is used and for the heterogeneous block, Lifting Wavelet Transform is used. In this technique imagequality is measured objectively, using peak signal noise ratio or picture quality scale using perceived image quality.

***Key Words*:**SPIHT, Wavelet, Lifting sceme, Enropy Coding, Image Compression

1.INTRODUCTION

Digital image compression is now essential. Internet teleconferencing, High Definition Television (HDTV), satellite communications and digital storage of images will not be feasible without a high degree of compression. Wavelets became popular in past few years in mathematics and digital signal processing area because of their ability to effectively represent and analyze data. Typical application of wavelets in digital signal processing is image compression. The compression provides to reduce the cost of storage and increase the speed of transmission. Image compression is used to minimize the size in bytes of a graphics file without degrading the quality of the image. There are two types of image compression is present lossy and loss less[18]. The lossy type aims to reduce the bits required for storing or transmitting an image without considering the image resolution much and the lossless type of image compression focuses on preserving the quality of the compressed image so that it is same as the original image.

Image compression algorithms based on Discrete Wavelet Transform (DWT),such as Embedded Zero Wavelet (EZW)[3] which produces excellent compression performance, both in terms of statistical peak signal to noise ratio (PSNR) and subjective human perception of the reconstructed image. Said and Pearlman further enhanced the performance of EZW by presenting a more efficient and faster implementation called set partitioning in hierarchical trees. SPIHT is one of the best algorithms in terms of the peak signal-to-noise ratio (PSNR) and execution time.In this paper, we propose an algorithm for degital image compression based on lifting base wavelet transform coupled with SPIHT (Set Partition in Hierarchical Trees) coding algorithm, of which we applied the lifting structure to improve the drawbacks of conventional wavelet transform. We compared the results with various wavelet based compression algorithm. Experimental results show that the proposed algorithm is superior to traditional methods for all tested images at low bit rate. Our algorithmprovides better PSNR, Quality factor and MSSIM values for medical images only at low bit rate. Compressed image can be represent in various format such as GIF, JPG, BMP and PNG.

2. Methodology

A.SPIHT:SPIHT is Set Partitioning In Hierarchical Trees. It is the wavelet based compressioncoder. It divides the wavelet into Spatial Orientation Trees. SPIHT codes a waveletbytransmitting information about the significance of a pixel. It is a method of coding anddecoding the wavelet transform of an image.

1. Implementation of SPIHT:The basic principle is progressive coding which process the image respectively to alowering threshold. First step, the original image is decomposed into sub bands. Then themethod finds the maximum iteration number. Second, the method puts the DWTcoefficients into a sorting pass that finds the significance coefficients in all coefficientsand encodes the sign of these significance coefficients. Third, the significancecoefficients that can be found in the sorting pass are put into the refinement pass that usestwo bits to exact the reconstruct value for approaching to real value[1]. The result is inthe form of a bit stream.It has three lists to store the values. They are List of Insignificant Pixels (LIP), List ofSignificant Pixels (LSP), and List of Insignificant Sets (LIS).

B.MSPIHT: In SPIHT, the usage of three temporary lists are quite memory consuming. In addition,during coding the elements in the lists are often inserted or deleted, thus, greatly increasethe coding time with the expansion of the lists.Thus Modified SPIHT algorithm varies from SPIHT algorithm by the way in which thesubsets are partitioned and significant information is conveyed. In the proposed MSPIHTalgorithm, the sorting pass and the refinement pass are combined as one scan pass. Thelists LIP and LSP are realized in one RAM module and consequently the area informationis stored. According to the characteristic of DWT, if a coefficient is significant at a certainthreshold then its neighbors will be significant at the next threshold with a highprobability. So we can scan the neighbors of significant coefficients in advance, so thatmore significant coefficients can be encoded at a specified bit rates.The wavelet Lifting Scheme is a method for decomposing wavelet transforms into a setof stages. Lifting scheme algorithms have the advantage that they do not requiretemporary arrays in the calculations steps and have less computation.

A. Splitting

In this stage the input signal is divided in to two disjoint sets, the odd (X [2n+1]) and theeven samples (X [2n]).

B. Lifting

In this module, the prediction operation P is used to estimate X0(n) from Xe (n) andresults in an error signal d(n). Then we update d (n) by applying it to the updateoperation U, and the resulting signal is combined with Xe (n) to S(n) estimate, whichrepresents the smooth part of the original signal.

C. Scaling

A normalization factor is applied to d (n) and s(n), respectively. In the even-indexed partS (n) is multiplied by a normalization factor Ke to produce the wavelet sub-band XL1.Similarly in the odd-index part the error signal d(n) is multiplied by K0 to obtain thewavelet sub band XH1. The output result is XL1 and XH1 by using the lifting-based WTare the same as those of using the convolution approach for the same input. For liftingimplementation, the CDF 9/7 wavelet filter pair can be factorized into a sequence ofprimal and dual lifting. The most efficient factorization of the poly phase matrix for the9/7.

3.Performance Of Image Compression Scheme

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K: the 4×4 block to be processed.
L: the 2×2 sub-block of K.
n: the bit-plane number
Refinement Pass (RP):
for each L ∈ K such that S_{n+1}(L) = 1 do
    for each w(i) ∈ L do
        output S_n(w(i)) (= the nth bit of |w(i)|);          # magnitude bit
        if S_{n+1}(w(i)) = 0 ∧ S_n(w(i)) = 1 then
            output the sign of w(i);                          # sign bit
    set S_n(L) to 1

Sorting Pass (SP):
if S_{n+1}(K ∪ D(K)) = 0∧ ~ (parent(K) ∧ S_n(parent(K)) = 0)
then
    output S_n(K ∪ D(K));                                     # sorting bit
    if S_n(K ∪ D(K)) = 1 then
        for each L ∈ K such that S_{n+1}(L) = 0 do
            output S_n(L ∪ D(L));                             # sorting bit
            if S_n(L ∪ D(L)) = 0 then
                set S_n(L) to 0
            else
                set S_n(L) to 1
else
    for each L ∈ K such that S_{n+1}(L) = 0 do
        set S_n(L) to 0

First Refinement Pass (FRP):
for each L ∈ K such that S_n(L) = 1 and S_{n+1}(L) = 0 do
    set S_n(L) to 1
    for each w(i) in L do
        output the nth bit of |w(i)|                          # magnitude bit
        if S_n(w(i)) = 1 then
            output the sign of w(i)                           # sign bit
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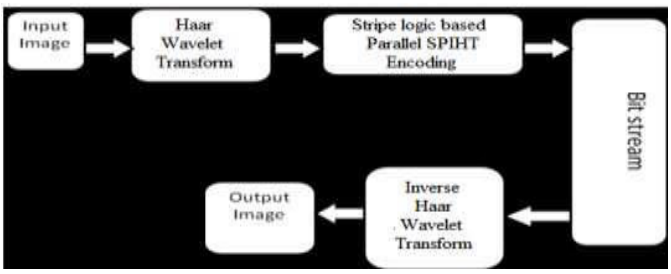

Fig 1. Block diagram of the entire process

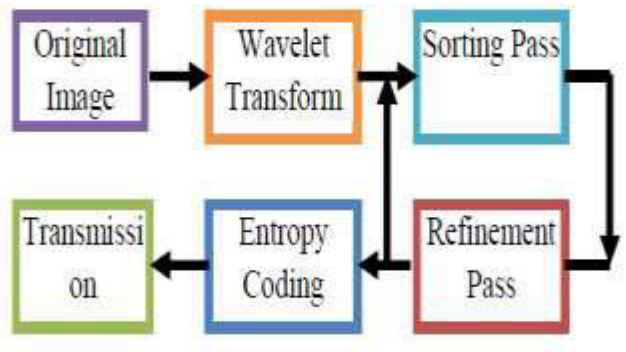

Fig.2Flowchart of SPIHT Algorithm

3. CONCLUSIONS

The proposed method is based on HWT and SPS technique for medical images is presented for real time applications. This technique reduces the memory requirements, enhances the speed and retains all the advantages of embedded coding. The utilization of this method can reduce the MSE or enhance the PSNR values which are the important performance parameters.HWT makes itself a standard technique for its high efficiency. SPIHT which is a powerful technique for still images offers various good characteristics like, good image quality, high PSNR, fast coding and decoding etc., along with HWT technique provides an efficient design. Experimental results demonstrate that the PSNR value obtained by this method may reach up to 83.6dB . As a future enhancement, the work can be extended for designing higher resolution images of size 512×512, 1024×1024 etc. Number of decomposition levels can be increased that may provide still better compression. Other coding technique can be used instead of bit-plane coding since it is not relevant for decoding to obtain still better results.

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