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Hybrid Algorithm for 2D Image Compression using Wavelet Transform

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ABSTRACT: Set partitioning in Hierarchical trees(SPIHT) is one of the most efficient algorithm known today.Many new algorithms for image compression based on wavelets have been developed recently.This paper gives a detailed explanation of SPIHT algorithm with the combination of Lempel Ziv Welch compression technique for image compression by MATLAB implementation.A pyramid structure have been created by the SPIHT algorithm based on a wavelet decomposition of an image.Lempel Ziv Welch is a universal lossless data compression algorithm guarantees that the original information can be exactly reproduced from the compressed data.This paper describes the combination of SPIHT algorithm and Lempel Ziv Welch technique for better compression of 2D .

KEYWORDS: Lempel Ziv Welch(LZW),SPIHT,Wavelet

I. INTRODUCTION

Today ,wavelet transform has been widely applied and developed in image processing and image compression .DWT is the part of mathematics that have a best localization property in the time domain and in the frequency domain..'Embedded Zerotree Wavelet' is very simple and effective compression algorithm,but many improvements over 'Embedded Zerotree Wavelet'are achieved by SPIHT algorithm by Amir Said and William Pearlman .In this SPIHT algorithm ,many wide sense Zerotrees are effectively found and they are representing by separation of the tree root from the tree.From the result of this technique ,this compression algorithm is very efficient and giving better results.The SPIHT algorithm creates a pyramid structure based on a wavelet decomposition of an image.The wavelet coefficients at the top side of the pyramid has a strong spatial relationship with their children.This SPIHT algorithm bases its efficiency by searching for significant pixels throughout the entire pyramid structure tree.If the parent root component having the value zero means all the child component value zero.so it easily neglected all the unwanted components and finally it stores only the correct information bytes.

Lempel Ziv Welch is a universal lossless data compression algorithm.In this paper the main focus point is the usage of hybrid algorithm,which is the combination of SPIHT algorithm with the Lempel Ziv Welch compression algorithm for 2D and 3D images.This algorithm guarantees that the original information cannot be changed after the compression.This Lempel Ziv coding scheme is universal and this algorithm uses adaptive approach and fixed size window that is sliding window principle.This first paper by,Ziv and Lempel in 1977 about lossless compression with an adaptive dictionary that is LZ77. As mathematical tool, wavelets can be used to extract information from many different kinds of data, including - but certainly not limited to - audio signals and images. Sets of wavelets are generally needed to analyze data fully. A set of "complementary" wavelets will deconstruct data without gaps or overlap so that the deconstruction process is mathematically reversible. Thus, sets of complementary wavelets are useful in wavelet based compression/decompression algorithms where it is desirable to recover the original information with minimal loss. In today's multimedia wireless communication, major issue is bandwidth needed to satisfy real time transmission of audio and video data. The solution to this problem is to efficiently compress audio and video data for a given SNR. Wavelet transform is an evolving technology which offers far higher degrees of data compression compared to standard transforms such as DCT etc. In this talk we will be discussing concepts of wavelet transform and its applications to image compression and processing. The same can be extended to video processing.For that we are in the need of image compression algorithm.Here in this hybrid algorithm technique the two algorithm which can be used here that is the SPIHT algorithm and the Lempel Ziv Welch compression algorithm.By combining the two algorithm we may achieve to reduce number of bits during the transmission and finally we may get the good compression ratio.LZW lossless compression was published by Welch in 1984 as an improved implementation of LZ78 by Lempel and Ziv.This is relatively simple and efficient algorithm and it could used a 4k-byte window as a dictionaryFinally in this paper ,the main focus is to combine the two algorithm.A very large number of statistical results shows that this method saves a lot of bits during transmission and compression performance should be enhanced.Here the section II elaborate the entire block system ,section A and section B explain the SPIHT algorithm and Lempel Ziv Welch technique respectively .Finally section IV adopt with the results and comparison then the final section V gives the conclusion of the entire system.

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II.BLOCK SYSTEM

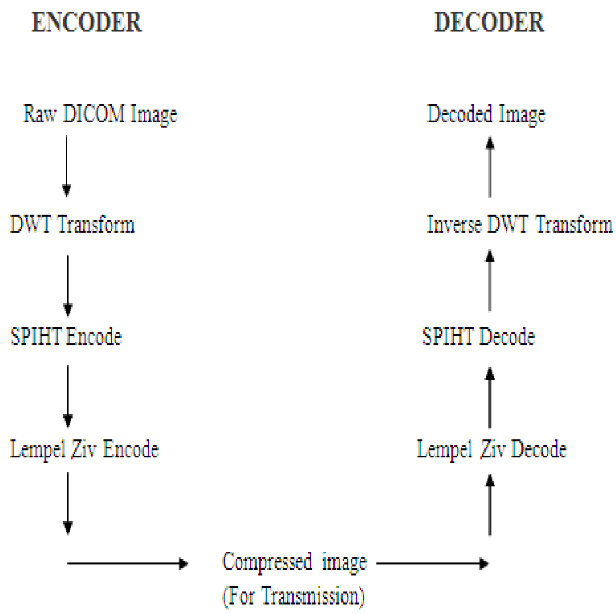

Fig 1.Block diagram of compression and decompression

III.ALGORITHM

A.SPIHT Algorithm

B.Lempel-Ziv Welch Algorithm

A.ANALYSIS OF SPIHT ALGORITHM

The 4-level wavelet decomposition of the spatial orientation tree structure is in fig.1.Many new algorithm for image compression based on wavelets have been recently developed.These methods having many practical advantages .They are continuous tone and bit level compression ,lossless and lossy compression ,superior low –bit rate performance,High pixel accuracy and resolution etc.The SPIHT algorithm satisfy all the above goals very effectively.This is having some key concepts like (1)ordered bit-plane transmission of refinement bits.(2)partial ordering of wavelet coefficients by magnitude with transmission of ordered by a subset partitioning the SPIHT algorithm the orders the wavelets coefficients according to a significant test and stores this information in three separate lists.They are list of insignificant sets(LIS), List of significant pixela(LSP), and the list of insignificant pixels(LIP).Finally these lists are also implemented by array structure.This is creating a four way decomposition that is LL(Low pass then low pass), LH(Low pass then high pass), HL(high pass then high pass),and HH(High pass then high pass) then LL version is again composed into 4 way.This process is repeated until the top of the pyramid is reached.SPIHT is having such a good properties like idempotency-lossless recompression at same bit rate ,recompression builds same ordered lists and transmit same bits,multiresolution scalability that is Encoder/decoder tracks resolution of bits automatically, low complexity that is no floating point multiplications,No estimation,No rate allocation,search only for largest msb in transform-quick first pass,second pass does coding,addressing increment,decrement bit shifts,efficient without entropy coding,most computation for transform,good memory usage,1/4 block size for LIS and LIP initiated with co-ordinates of root level of transform in all planes. No explicit bit allocation and different planes may have different transforms .finally this is a simple and efficient algorithm with many unique and desirable properties. Note that different compression methods were developed specifically to achieve at least one of those objectives. What makes SPIHT really outstanding is that it yields all those qualities simultaneously. So, if in the future you find one method that claims to be superior to SPIHT in one evaluation parameter (like PSNR) Many researchers now believe that encoders that use wavelets are superior to those that use DCT or fractals. We will not discuss the matter of taste in the evaluation of low quality images, but we do want to say that SPIHT wins in the test of finding the minimum rate required to obtain a reproduction indistinguishable from the original. The SPIHT advantage is even more pronounced in encoding color

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images, because the bits are allocated automatically for local optimality among the color components, unlike other algorithms that encode the color components separately based on global statistics of the individual components. You will be amazed to see that visually lossless color compression is obtained with some images at compression ratios from 100-200:1.

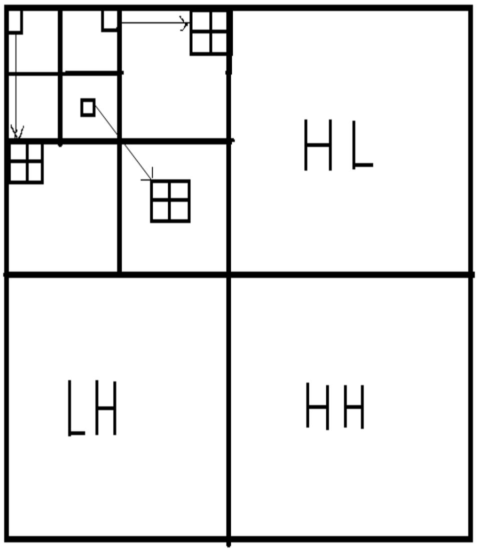

Fig 2.Pyramid structure by the four way decomposition in SPIHT

SPHIT Algorithm steps:
A)Initialization:
#Output m should be calculated from the co-efficients;
#Set the LSP as null list ;
#Set the LIP=(a,b) which belongs to H(a,b);
#Set the LIS=(a,b) which belongs to H(a,b);
but D(a,b) not equal to null set.
B)Sorting pass.
B.1 for each entry (a,b) in the LIP do:
B.1.1 Output *P* (a,b)
B.1.2 If P(a,b)=1 move (a,b) to the LSP and
output the sign of *C*
B.2 for each entry (i,j) in the LIS do:
B.2.1 if the entry is A type then
output P(D(a,b));
if P(D(a,b))=1 then
# for each (m,n) which belongs to O(a,b) do:
* Output P(m,n)
* If P(m,n)=1 then add(m,n) to the LSP and
output sign of C;
* If P(m,n)=0 then add (m,n) to the end of LIP
# If L(a,b) not equal to null then move (a,b)to
the end of the LIS as entry of type B and go to step B.2.2
otherwise remove the entry from the LIS;
B.2.2 if the entry is of type B
Output P(L(a,b))
If P(L(a,b))=1then
add each (m,n) which belongs to O(m,n) to the end
of the LIS as entry of the type A
remove (m,n) from the LIS
C)Refinement pass.
For each entry (m,n) in the LSP except those included
in the last sorting pass , output m th most
significant bit of C

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D)Quantization step.
decrement the m by A and go to step B
Notations are as follows:
L(a,b)=D(a,b)-O(a,b)

O(a,b): set of coordinates of the off-spring (a,b)
D(a,b): set of coordinates of all descendants (a,b)
H(a,b): set of coordinates of all tree roots in the
Highest level of the pyramid.
The LIS,LIP and LSP lists were also built using array structure . These arrays are especially useful when handling the refinement pass as these lists can grow or shrink at the run time.Here biorthogonal filters 4.4 is used.Finally by the SPIHT algorithm,we may calculate ,the wavelet decomposition,spiht encoding.spiht decoding and wavelet reconstruction. Further we introduce the Lempel – Ziv Welch compression technique.

B.Analysis of Lempel Ziv Welch Algorithm
This LZ algorithm guarantees that the original information can be exactly reproduced from the compressed data.This coding scheme is universal and this LZ77 improvements are LZR(references to any point in processed data),LZSS(codewords without symbol,output or symbol),LZB(increasing pointer size,no lookahead buffer),LZH(LZSS ang Huffman coding(Huffman table needs to be stored /transmitted)).LZ77 is a sliding window compression. The decompression algorithm of LZ77 is even simpler and very effective technique.Here we combine the SPIHT algorithm with Lempel Ziv Welch technique for further compression and finally we saves a lot of bits during transmission.Finally we getting the good compression ratiofor the 2D and 3D dicom medical images.The LIS,LIP and LSP lists were also built using array structure . These arrays are especially useful when handling the refinement pass as these lists can grow or shrink at the run time.Here biorthogonal filters 4.4 is used.Finally by the SPIHT algorithm,we may calculate ,the wavelet decomposition,spiht encoding.spiht decoding and wavelet reconstruction. Further we introduce the Lempel – Ziv Welch compression technique.

The main data structure in LZ77 is a text window,divided into two parts.The first consist of a large block of recently decoded text.The second normally much smaller,is a look-ahead buffer.The LZ77 algorithm issued a sequences of tokens.Each token consists of three different data items. They are (a)an offset to a phrase in the text window;(b)The length of the phrase;(c)The first symbol in the look-ahead buffer that follows the phrase.The code to implement this compression algorithm should be fairly simple.The decompression algorithm for LZ77 is even simpler, it does not have to do the comparisons.It reads in a token , output the indicated phrase, outputs the following character , shifts and repeats. The above steps to be involved for LZW compression and decompression. This LZ algorithm gives the better compression enhancement performance.

IV.RESULTS AND COMPARISON

A.LENA 2D COLOR IMAGE

Fig 3.Pyramid tree generated by the four –way decomposition

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ORIGINAL AND RECONSTRUCTED IMAGE

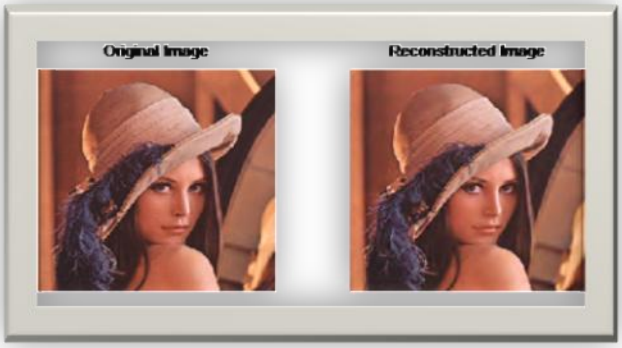

Fig 4.original and reconstructed images of 2D lena color image

Table 1.statistical results of 2D lena

PSNR Value	35.07 db
MSE Range	20.2186
Com.File.Size	58682
Orig.File.Size	492080
Compression Ratio	8.3855
Elapsed time	1.196 sec

DICOM 3D IMAGES

B.ABDOMEN GRAY IMAGE

Fig 5.Four way decomposition structure of abdomen gray image

ORIGINAL AND RECONSTRUCTED IMAGE

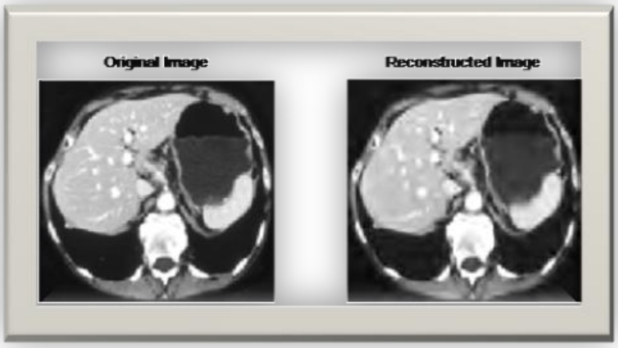

Fig 6.original and reconstructed image of abdomen gray image

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Table 2.statistical results of abdomen gray image

PSNR Value	33.56 db
MSE Range	28.6424
Com.File.Size	65486
Orig.File.Size	1497020
Compression Ratio	22.8602
Elapsed time	1.226 sec

C.HEMORRAGE GRAY IMAGE

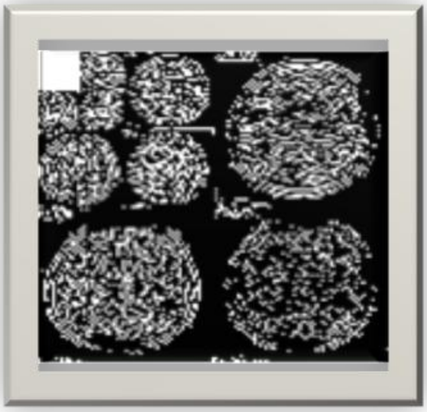

Fig 7.Four way decomposition of hemorrage image

ORIGINAL AND RECONSTRUCTED IMAGE

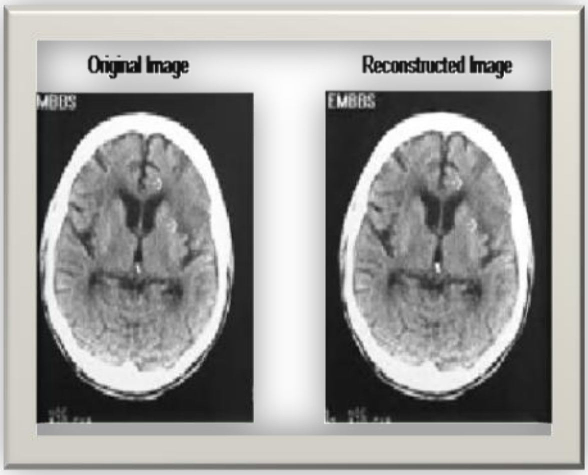

Fig 8.original and reconstructed image of hemorrage gray

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Table 3.statistical results of hemorrhage gray

PSNR Value	32.25 db
MSE Range	38.7449
Com.File.Size	7236
Orig.File.Size	63806
Compression Ratio	8.8178
Elapsed time	1.256 sec

D.ABDOMEN COLOR IMAGE

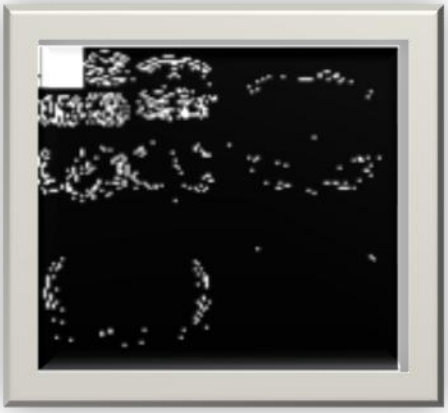

Fig 9.Four way decomposition of abdomen color image

ORIGINAL AND RECONSTRUCTED IMAGE

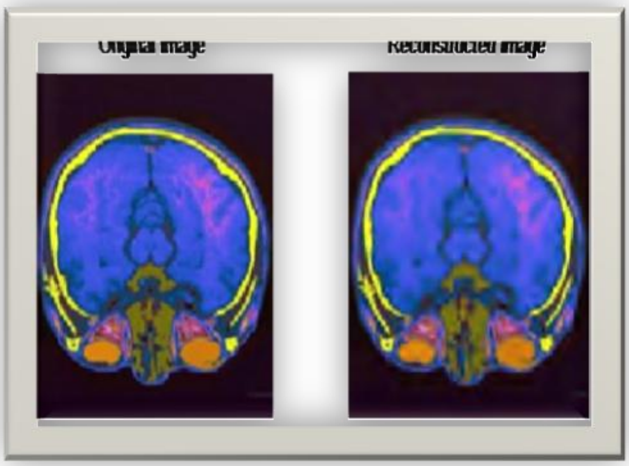

Fig 10.original and reconstructed image of abdomen color

Table 4.statistical results of abdomen color

PSNR Value	32.46 db
MSE Range	36.9329
Com.File.Size	53474
Orig.File.Size	460854
Compression Ratio	8.61828
Elapsed time	1.615 sec

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E.SKEL COLOR IMAGE

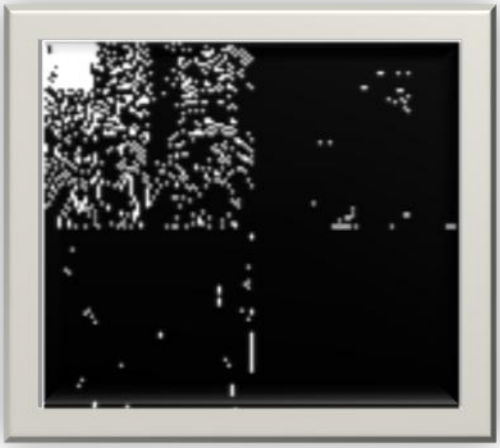

Fig 11.Four way decomposition of skel color image

ORIGINAL AND RECONSTRUCTED IMAGE

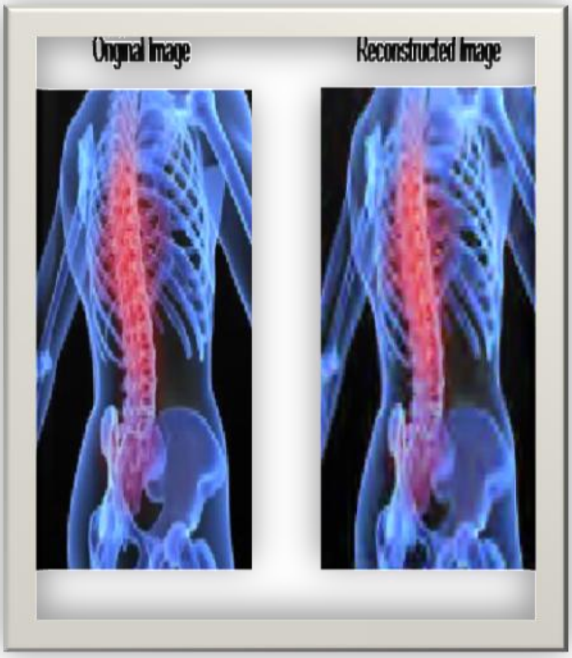

Fig 12.original and reconstructed image of skel color

Table 5.statistical results of skel color

PSNR Value	31.46 db
MSE Range	46.472
Com.File.Size	70106
Orig.File.Size	117920
Compression Ratio	1.6820
Elapsed time	1.253 sec

EXPERIMENTAL RESULTS

Algorithm	Metrices	2D color Lena Image	3D Gray Abdomen Image	3D gray hemorrage Image	3D color Abdomen image	3D color Skel Image
SPIHT	Original file size	492080	1497020	63806	460854	117920
SPIHT with Lempel Ziv Welch	Compress File size	58682	65486	7236	53474	70106
SPIHT with Lempel Ziv Welch	Compression Ratio (CR)	8.385	22.860	8.8178	8.61828	1.6820
MSE	Mean Square Error	20.21	28.642	38.7449	36.9329	46.472
PSNR	Signal Noise Ratio	35.07 db	33.56 db	32.25 db	32.46 db	31.46 db
Elapsed Time	Time	1.196 sec	1.226 Sec	1.256 sec	1.615 sec	1.253 sec

Most of the color image compression techniques reduce the redundancy between color components (R,G,B).All the medical images having three layers.if gray image means it is luminance components.The signal noise ratio should be calculated here.If the rate is increased PSNR value should be increased also elapsed time also increased.LZ algorithm is the lossless compression technique so the signal noise ratio cannot be changed for LZ compression after executing the SPIHT algorithm.so for both algorithm the PSNR value is same and the size of the image only modified that is compressed.

V.CONCLUSION

SPIHT is computationally very fast algorithm relatively lossy technique .In other hand Lempel-Ziv Welch algorithm is the lossless compression algorithm.In the existing paper they combined SPIHT with Huffman encoding technique.Huffman is the lossy compression algorithm.Here proposing a simple and effective method such as the combination of SPIHT with Lempel-Ziv algorithm for further compression .From this SPIHT the essential content does not damaged and for further compression ,combine the SPIHT with LZ algorithm.By this method we get the good compression ratio and this method saves a lots of bits during transmission and giving the good compression ratio.An experimental results shows that this hybrid algorithm gives a better result for 2D image compression.

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