ANALYSIS OF SPHIT AND STW PARAMETERS IN MEDICAL ULTRASOUND IMAGE COMPRESSION USING WAVELET ALGORITHM TECHNIQUES

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ABSTRACT:

Medical Ultrasound is essential diagnostic tools for women health comparing with other modalities. As it is non-radiated, harmless to human organs it is globally accepted as a periodical procedure for obestritics and gynecology healthcare. The research opportunities in ultrasound image enhanced applications area are plenty, similarly compression algorithms for medical images such as CT and MRI are processed by the same algorithm, so this paper is aimed at using the best compression algorithm for the compression of especially ultrasound images. To analyse and evaluate the effectiveness of wavelet based embedded zerotree wavelet, set partioning in hierarchical tree, wavelet difference reduction, spatial orientation tree wavelet compression for ultrasound images. A comparative study based on the performance parameters such as peak signal to noise ratio (PSNR), compression ratio (CR), bits per pixel (BPP) and mean square error (MSE). The best algorithm for the ultrasound image compression among the above methodologies is studied in detail and is implemented by using best tool.

KEYWORDS:-

Embedded Zero tree Wavelet (EZW), Set Partioning In Hierarchical Tree(SPIHT), Wavelet Difference Reduction (WDR), Spatial Orientation Tree Wavelet Compression(STW), Peak Signal To Noise Ratio (PSNR), Compression Ratio (CR), Bits Per Pixel (BPP) and Mean Square Error (MSE).

INTRODUCTION:

In digital image compression, image enhancement is based upon image compression and reconstruction of image with certain parameters related to human perception. This paper is mainly focusing on ultrasound image compression using specific algorithm. Ultrasound image compression is mainly used instead of CT and MRI since the viewing pattern of the diagnostic organ varies. The ultrasound images can be viewed small parts of organs, cross sectional view, para-sternum, apical and sub-costal positions. The technique is portable, less expensive and the exposure to radiation does not harm much. Ultrasound are used for visualizing muscles, tendons, internal organs, to determine size, structure, lesions and abnormalities. Generally ultrasound uses high frequency probes (10-15 MHZ) than low frequency (5-10 MHZ) because it provides better resolution and less penetration.

There are a lot of compression algorithms for medical images but the same algorithm cannot be used to compress images of different modalities. Since the picture resolution varies for different images. The medical images should be preserved for a long period of time i.e., 15-20 years so they used PACS (Picture Archiving Communication System) for storing it. These PACS will consist of periodical patient data and images, the images need effective compression algorithm.

Objective of this paper is the ultrasound medical images shall be transmitted very easily without affecting the original image. This is possible only if the proper image compression algorithm is used to compress, store and retain the image. The ultrasound image compression should posses the following.

i) The distinction of errors in the compressed ultrasound image depends upon the location of original image.

ii) The compressed ultrasound image should be exact depiction of original image and should have same information as that of original image.

iii) The ultrasound image is compressed with the following wavelet based compression algorithms and the best algorithm and tools are analyzed in terms of performance comparison.

COMPRESSION ALGORITHM:

Lossy and lossless compression standards are used in medical images based on ROI and Non-ROI image regions. Compression of ultrasound images has many transformations. The FT, DTFT transforms were obsolete as it does not contain any internal information of source data, but the wavelet based image compression is used with additional features such as compactness, easy process and robustness. The wavelet based compression algorithms produce very low bit error rate for given compression ratio and have good image quality.

Fig 1. Compression steps using wavelet based transformation.

There are many wavelet compression algorithms being applied for specific applications, one among the best is analysed here for ultrasound image compression with various parameters.

1. EZW (Embedded Zero-tree Wavelet):

EZW algorithm can be used in ultrasound image processing to show the full power of wavelet based image compression and stream of one dimensional ultrasound scan data. It is a process of encoding the magnitude bit stream transform in a progressive manner. It allows concise encoding of significant values position.

EZW uses embedding process called bit–plane encoding. This bit plane encoding is continued till the quantized transform magnitude is obtained which is close as the desired transform magnitude with greater accuracy.This coding technique provides multi resolution wavelets with high quality image. The first significant bit is always 1 if not encoded the sign is encoded first. This coherent ordering of encoding the highest magnitude bits are encoded first and this allows for progressive transmission .The wavelet transform is well suited for bit-plane encoding because the image have few magnitudes.

The Embedded Zero tree encoding is incredibly implicit,computationally compact and the position of significant values description is got by the position of insignificant values. These insignificant values are organized by zero tree(quad tree).

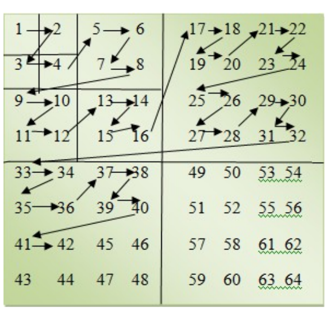

Fig2.Scanning order of EZW for Ultrasound multi resolution image.

2. SPIHT (Set Partioning In Hierarchical Trees)

Set Partioning In Hierarchical Trees is a wavelet based image compression algorithm. In SPIHT initially the image is converted into its wavelet transform and then information is transmitted about the wavelet co-efficient.SPIHT is a highly refined version of EZW algorithm and it operates on an entire image at once. It obtains high PSNR values for a given compression ratio. It is the most widely used image compression algorithm. The coding and decoding of the images is faster than EZW and provide better error protection and high quality image.

The Set Partioning refers to the position of quad-trees of wavelet transform values at a given threshold.The SPIHT coding uses three list i.e. List of significant pixels (LSP),List of insignificant pixels (LIP),List of insignificant sets (LIS) and two passes sorting and refinement pass. The three lists contain location of the co-efficient along with their co-ordinates.It is suitable for telemedicine because it uses embedded coding with progressive transmission and this is a major advantage of it. The ordering of co-efficient is from maximum to minimum. SPIHT algorithm has fast coding time ,precise rate control, can be used for lossless compression and can code to exact bit rate.

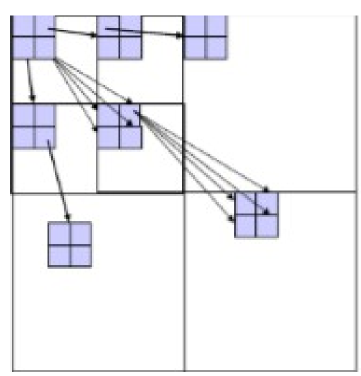

Fig 3. SPIHT scanning order for medical image

3. STW (Spatial Orientation Tree Wavelet):

STW is Spatial Orientation Tree Wavelet is a modified form of SPIHT algorithm .STW technique is based on the partioning of wavelet and by keeping the insignificant co-efficient together in larger subsets. It uses spatial relationship between the wavelet co-efficient.

A Spatial Orientation Tree is defined as the tree structured set of co-efficient with the tree root started at one of directional bands at any level. The three trees carry the high frequency information in three different orientations horizontal, vertical and diagonal of corresponding spatial region. If tree root starts at highest level directional band it is depth spatial orientation.

STW is essentially SPIHT algorithm and only difference is that in organizing the output coding. SPIHT is easily explained by underlying the concepts of STW. It uses a state transition model for encoding the information. The location of transform values undergo state transitions. This allows STW to reduce the number of bits needed for encoding.

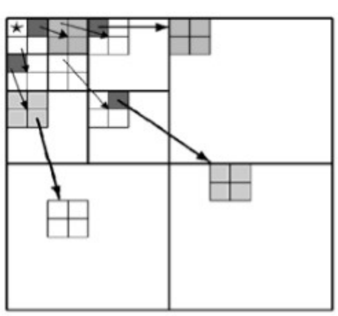

Fig 4. Scanning order of STW in medical image compression.

4. WDR (Wavelet Difference Reduction):

WDR is a wavelet based image compression One defect of SPIHT is that it only locates the position of significant co-efficient which makes the operation difficult for exact transform values position .So to overcome this WDR uses region selection called Region Of Interest. In this only a portion which requires high resolution is selected and the transformation is done.WDR do not produce high PSNR values than SPIHT but produce high quality images at high compression ratio.

In WDR, the indices of significant values is not considered instead the successive difference between the indices is taken. Then binary expansion of the indices difference is done. Then the most significant for these will be 1 so it can be dropped and signs are used as seperators in the stream.WDR replaces the significant pass in the bit plane encoding.

PERFORMANCE PARAMATERS:

The ultrasound image compression is analyzed based on the below parameters such as PSNR,MSE,CR and BPP.

PSNR:

PSNR is Peak Signal to Noise Ratio .It is used to measure the quality of reconstructed image. For higher PSNR values it produces superior quality images.

$$PSNR=10 \log (2^n-1)^2/MSE$$

Where n is the pixels and MSE is Mean Square Error.

MSE:

MSE is Mean Square Error .It is the difference between original and reconstructed image.

$MSE=[p(i,j)-p'(I,j)]^2$

Where p(i,j) is original data and p'(i,j) is the noise produced due to compression. Lower the value of MSE the image is of better quality.

CR:

CR is Compression Ratio. The ratio between the number of bits required to represent an image before compression to the number of bits required to represent an image after compression.

CR=Image before compression/Image after compression

BPP:

BPP is Bits Per Pixel. It is the number of distinct color for given pixel. for 1-bit per pixel it can either be on or off. For 2-bpp it has 4 colors. For 3-bpp it has 8 colors.

1 bpp,2^1=2 colors2 bpp,2^2=4 colors

3 bpp,2^3=8 colors

Medical Image Inputs:

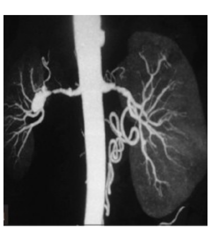

Fig 5 & 6. CT kidney image tagged as 1.Jpg and US Gallbladder image tagged as 2.Jpg.

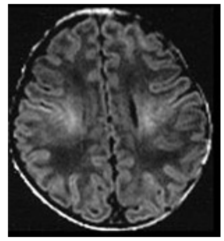

Fig 6 & 7. MRI brain image tagged as 3.Jpg and X ray extremity image tagged as 4.Jpg.

Fig 8. Mammogram image tagged as 5.Jpg

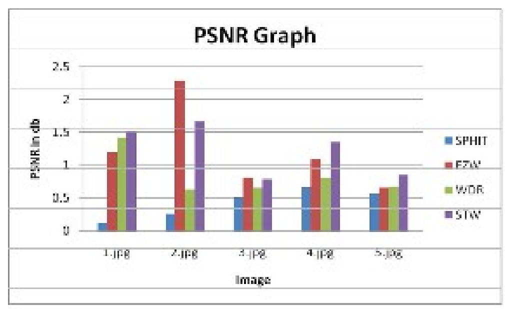

Fig 9. PSNR graph for different compression techniques.

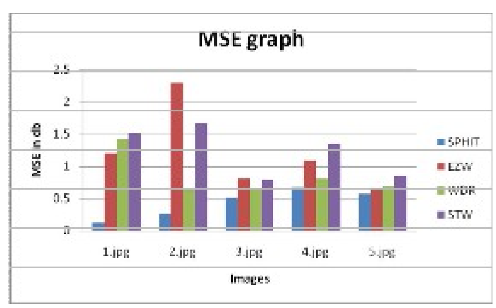

Fig 10. MSE graph for different compression techniques.

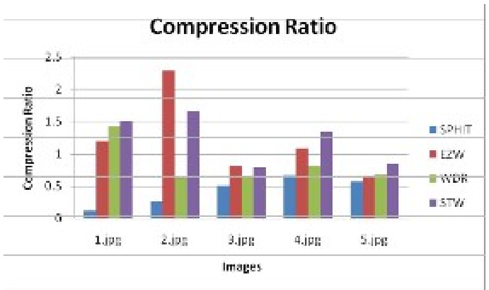

Fig 11. CR performance of above techniques in medical image compression.

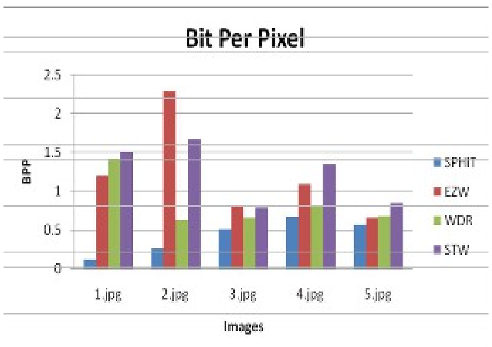

FIG 8. BPP performance in ultrasound medical image.

These are the different parameters for analyzing the best compression algorithm of images and in the same way the ultrasound image is being analyzed for same parameters by using the required software tools.

CONCLUSION:

Various methods and types of images are taken for performance analysis, here the Embedded Zero-tree Wavelet and Special orientation Tree Wavelet algorithms have better performance over other algorithm techniques. Also this paper concludes that though all the medical images are processed through common image processing technique, but each modality needs separate algorithm/technique for the bestperformance in image compression.

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