PERFORMANCE ANALYSIS OF SPIHT AND MSPIHT USING ULTRASOUND COMPOUND IMAGE

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ABSTRACT: *This paper presents the performance analysis of wavelet compression techniques SPIHT and MSPIHT used for compression of ultrasound compound images. The quality parameters were used as input to the correlation model for comparative performance analysis. The parameters used against the compression techniques include peak signal to noise ratio (PSNR) , normalized cross-correlation(NK) , average difference (AD) , structural content(SC) , maximum* ***difference*** *(MD) and Normalized Absolute Error (NAE). MSPIHT compression method was observed to perform better than the SPIHT in terms of PSNR and MD.*

KEYWORDS*: PSNR, AD, SC, NK, NAE, MD.*

I. INTRODUCTION

Image compression is a fast paced and dynamically changing field with many types of compression methods. Image compression plays a vital role in several important and diverse applications including tele-video conferencing, remote sensing, medical imaging and many more. It becomes necessary to identify and quantify the quality degradations in order to maintain the required quality of service. The compression technique plays a key role for transmitting critical medical information to reduce the transmission overhead. Further, These require fast transmission and large space to store data. Image compression is defined as minimizing the bits required to represent an image without degrading the quality of the image to an unacceptable level. Thus, by reducing the image size, we can allow more images to be stored in given amount of memory space and also reducing the time required to sent the image.

II. VARIOUS COMPRESSION TECHNIQUES

Image compression is of two types lossless and loss . The images can be recreated exactly without changing the power values in lossless type. Satellite image processing, medical field and document imaging mostly uses lossless compression as it does not bear any loss of data. On the contrary in lossy type, images cannot be recreated exactly after changes in the power values. Lossy encoding can be obtained with JPEG, LZW etc. The examples of lossless image compression techniques are EZW, WDR, SPIHT.

Wavelet transformation is performed on any image before applying any algorithm. This results in a multi scale representation. The correlation between neighbouring pixels is reduced by applying wavelet transform.The energy of the original image is concentrated in the lowest frequency band of transform domains[1]. Each row of the image array undergoes decomposition, resulting in an image whose horizontal resolution is reduced by factor of two and whose scale is doubled. The high pass (wavelet filter) component of the decomposition characterizes the high frequency information with horizontal orientation. Next the high pass and low pass sub images obtained by the row decomposition are separately filtered column wise to obtain for sub images corresponding to low-low pass, low-high pass, high-low pass and high-high pass row column filtering.

Embedded Zero Wavelet is an algorithm used in image compression and is based on wavelet theory, in this algorithm the image is further divided into sub bands. Such technique helps reducing the redundancy between the root and child node. The mechanism of EZW helps in understanding the significance of various factors involved in prioritization protocol based on successive approximations. In Zero tree wavelet theory the quad trees formed have absolute values higher for nodes as compared to the lowers nodes. The calculation of these values depends on the threshold which is to be determined from the level of quad tree to the total absolute value calculated from the node which is greater than the threshold [2].

SPIHT ALGORITHM

The algorithm of set partitioning in hierarchical tree is called as SPIHT algorithm, which is improved by the EZW coding. SPIHT imparts lower costs with respect to compression complexity and prediction, as proposed in JPEG and JPEG 2000.To achieve higher compression performances in the SPIHT algorithm, the image is first decomposed into a number of sub bands by means of hierarchical wavelet decomposition[3]. The sub bands obtained for two-level decomposition are shown in Fig. 1.

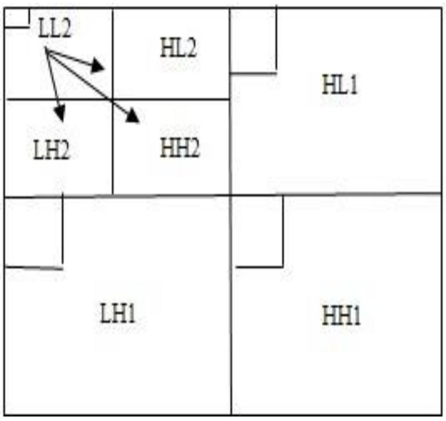

Fig. 1 two level wavelet decomposition and spatial orientation tree

The sub band coefficients are then categorized into sets known as spatial-orientation trees,which efficiently exploit the correlation between the frequency bands[4]. The coefficients in each spatial orientation tree are then progressively coded from the most significant bit-planes (MSB) to the least significant bit-planes(LSB), starting with the coefficients with the highest magnitude and at the lowest pyramid levels[5].

MSPHIT

An improved Set Partitioning In Hierarchical Trees(SPIHT) algorithm based on prior scanning the coefficients around which there were more significant coefficients was proposed to obtain better compression on image edge. The coefficients or sets were sorted according to the number of surrounding significant coefficients before being coded, and the previous significant coefficients were refined as soon as the sets around which there existed any significant coefficients had been scanned[6]. The scanning order was confirmed adaptively and did not need any extra storage. At a specified compression ratio, more significant coefficients can be coded[7]. The method can improve PSNR and the subjective visual experience compared with SPIHT as shown in experimental results.

EXPERIMENTAL SETUP

The image used for experiment in MATLAB is compound ultrasound medical image of fetal heart . The wcompress function was used to compress and then uncompress the image. The original image is shown in fig (2).The SPIHT and MSPIHT algorithms were applied on the ultrasound image to calculate the different values for peak signal to noise ratio (PSNR) , normalized cross-correlation(NK) , average difference(AD) , structural content(SC) , maximum difference(MD) and normalized absolute error(NAE) [8] . The following observations were made:

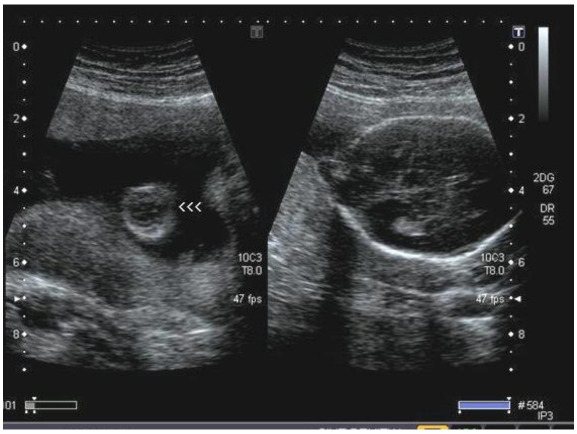

Fig. 2: Original ultrasound compound image

Following are the compressed images using different wavelet techniques

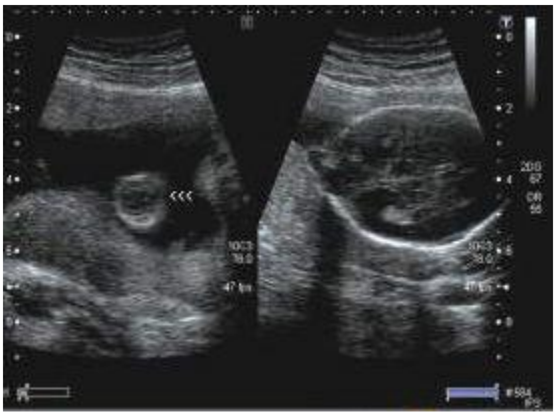

Fig. 3: Compressed ultrasound image using SPIHT, **PSNR= 33.8256,NK =0.9826,MD=43.44535**

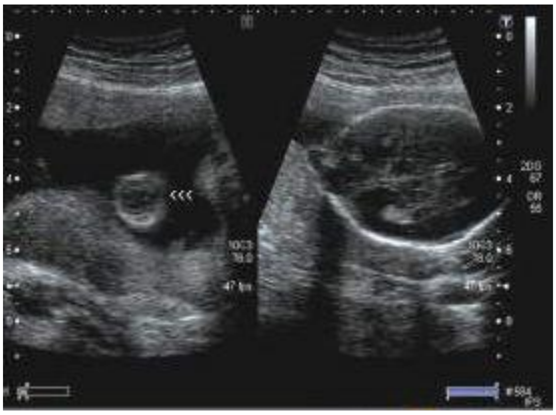

Fig. 4: Compressed ultrasound image using MSPIHT **, and PSNR = 94.1312,NK=0.9990,MD=0.0592**

III. PERFORMANCE ANALYSES

The performance analysis of the compression techniques was performed using the parameters as peak signal to noise ratio (PSNR) , normalized cross-correlation(NK) , average difference(AD) , structural content(SC) , maximum difference(MD) and normalized absolute error(NAE). The metrics are obtained from the equations as mentioned in Table.(1).

Table 1 performance comparison table

SNO.	Quality parameters	SPIHT	MSPIHT
1	PSNR	33.8256	94.1312
2	NK	0.9826	0.9990
3	MD	43.4535	0.0592
4	AD	0.0036	0.0004
5	SC	1.0290	1.0019
6	NAE	0.0683	0.0010

VARIOUS QUALITY PARAMETERS

1. The Peak Signal to Noise Ratio (PSNR): It represents a measure of the peak signal to noise ratio. It is expressed in decibels. The high value of the PSNR represents the better image quality.

PSNR=10*10log_{10}(255*255/mse)

2.Normalized cross correlati2on(NK): Normalized cross-correlation measures the similarity between two images.

$$NK=\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(a1,(i,j)a2(i,j)]}{\sum_{i=1}^{M}\sum_{j=1}^{N}\left(a,(i_j j)\right)^2}$$

3. Average Difference (A D): The average difference is the pixel difference between the filtered image and its corresponding degraded image. Average difference is given by

$$AD=\frac{\sum_{i=1}^{M}\sum_{j=1}(a1(i,j)-a2(i,j))}{MN}$$

where a1(i ,j)=reconstructed image at i and j coordinates of a2(i, j)= Perceived image

4. Structural Content (SC): It measures the closeness of two digital images. Higher the value of structural content specifies poor the quality of the image. Structural Content is given by :-

$$SC=\frac{\sum_{i=1}^{M}\sum_{j0=1}^{N}\left(a_2\ (i,j)\right)^2}{\sum_{i=1}^{m}\sum_{j=1}^{N}(a1(i,j))^2}$$

5. Maximum Difference(M D): It is the maximum of error signal and is given by

M D= MAX[a1(i, j)-a2(i, j)]

6. Normalized Absolute Error (NAE): Higher the value of NAE specifies lower the quality of the image.

$$NAE=\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(a1,(i,j)-a2(i,j)]}{\sum_{i=1}^{M}\sum_{j=1}^{N}|a1(i,j)|}$$

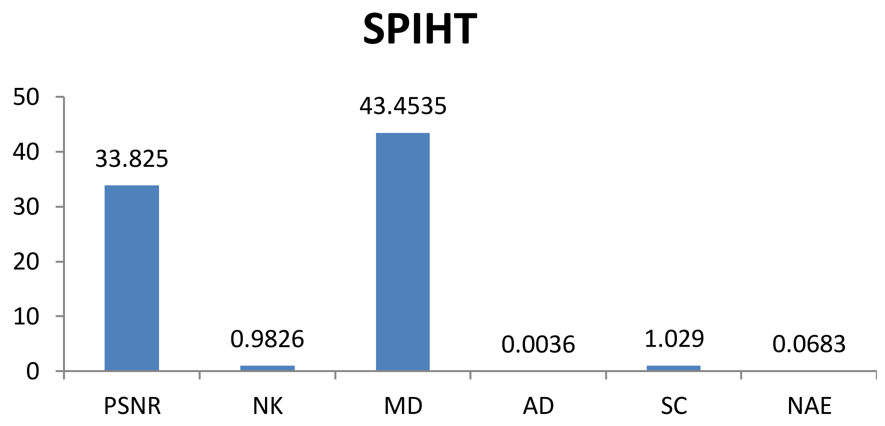

Fig. 5 results of SPIHT

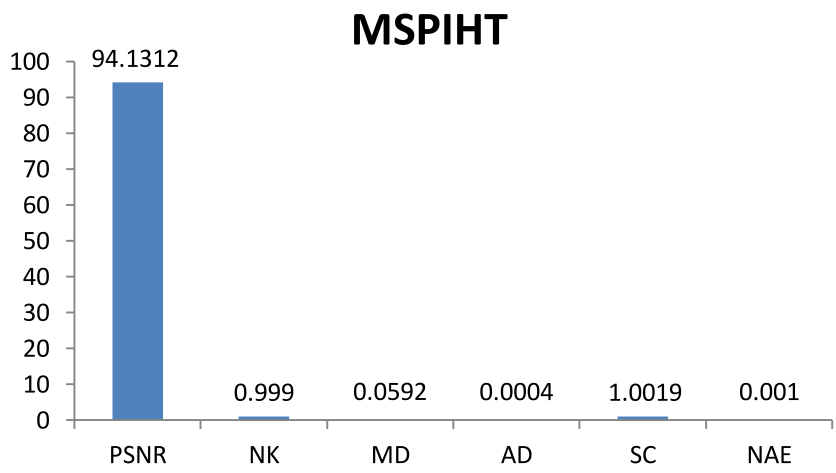

Fig. 6 results of MSIHT

IV. CONCLUSIONS:

On observing Fig .5 and Fig. 6 we came to the conclusion that MSPIHT is better than SPIHT.. The PSNR was extremely high in case of MSPIHT .Higher the value of MD and SC poorer is the quality of the image and here when we apply the modified SPIHT algorithm on the ultrasound image of fetal heart the MD and SC are relatively low as compared to the previous algorithm. Thus we came to the conclusion that MSPIHT is better than the SPIHT.

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