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DENOISING OF ULTRASOUND IMAGE USING WAVELET FAMILIES AND FILTERS

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ABSTRACT

Nowadays Noise is a major factor reducing quality of Medical images like MRI CT Scan Ultrasound etc. various types of Noise present in all medical images like Speckle, Additive noise. Speckle noise is a most commonly present in all medical images including ultrasound images. To extract useful information in the original form so transformations are used. DWT (Discrete wavelet transform) is the New and best technique for image denoising. Speckle noise is a high frequency content present in ultrasound images.

In this paper various techniques for removal of speckle noise from medical images based on Wavelet Multiresolution analysis and filtering techniques. Compare DWT with different wavelet families (Haar and Symlet) with wiener and median filtering techniques compared Result in terms of PSNR, Mean squared Error (MSE) and processing time.

Keywords*: *Denoising, DWT, Filter, PSNR and MSE, Symlet

I. INTRODUCTION

The Aim of Image denoising techniques are to remove noises without effecting the useful data. Different types of Denoising techniques now a days wavelets families are very efficient for enhance De-noising image.

Ultrasound imaging is very popular because of its various advantages: it is safe, non-invasive, portable, relatively inexpensive, and provide a real time image formation. But ultrasound images are less quality, mainly caused by multiplicative nature of the speckle noise. Exist in and lower the quality of ultrasound images Speckle noise effects the diagnosis and human interpretation. Transformations are applied in order to denoise the image. Various transformations are applied in order to denoise the image but wavelet transformation is more advantageous to use because it has variable window size. Various filtering techniques are used to improve PSNR to reduce MSE. Ultrasound image denoising should suppress speckle noise without the loss of image edges and structure information.

There are many traditional speckle denoising methods such as temporal averaging, median filter homomorphic Wiener filter, etc. Mostly use a single scale filter However, single scale analysis is insufficient to obtain perfect denoising for ultrasound images. In recent years, multi-resolution technology was introduced to de-noise ultrasound images. The part of image where information content present is more by providing large window size to that area and where information content is low we can provide small window size, so we can adjust the window size in wavelet transform Another main advantage of using discrete wavelet transformation is that after transformation it will not only provide frequency and amplitude information of signal but also provides temporal information whereas in other transformations temporal information but in another transform is lost. Median filter is used to preserve edges of the image and wiener filter is used as tailors itself to local variance and perform smoothing. An electronic copy can be downloaded from the conference website. For questions on paper guidelines, please contact the conference publications committee as indicated on the conference website. Information about final paper submission is available from the conference website.

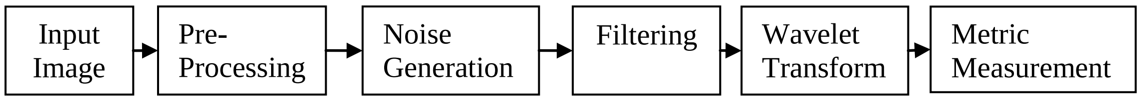

Fig. 1 Process Model

II. LITERATURE SURVEY

Khalifa Djemal (2005) proposed speckle deduction in ultrasound images by minimization of total variation. To limit the noise in an image, some techniques are based on the calculation of an average intensity in each pixel of the image by considering some neighbourhood. However, these techniques tend to attenuate contours present in the image. This affect edge and particularly penalizing for the segmentation algorithms whose finality is to find contours.

Badawi et al (2006) proposed a novel algorithm for speckle reduction in medical ultrasound imaging while preserving the edges with the added advantages of adaptive noise filtering and speed. Nonlinear image diffusion algorithm discussed in this paper incorporates local parameters of image quality, namely, scatterer density, image gradient and texture-based contrast, to weight the nonlinear diffusion process.

Ricardo G. Dantas et al (2007) proposed a novel method for speckle reduction in ultrasound medical imaging, which uses a bank of wideband 2-D directive filters, based on modified Gabor functions. This paper presents a single-image method for ultrasound speckle reduction, based on modified Gabor functions, henceforth called directive filters (DF).

Abraao et al (2010) proposed a model using the G 0 distribution and, under which, regions with different degrees of roughness and mean brightness can be characterized by two parameters; a third parameter, which is the number of looks, is related to the overall signal-to-noise ratio. They compared the performance of hypothesis tests that employ maximum likelihood estimation. They conclude that tests based on the triangular distance have the closest empirical size to the theoretical one, while those based on the arithmetic-geometric distances have the best power. Since the power of tests based on the triangular distance is close to optimum, the safest choice is using this distance for hypothesis testing, even when compared with classical distances as Kullback-Leibler and Bhattacharyya.

Paul Liu and Dong Liu (2011) developed an approach using a filter bank to create multiple looks to produce a compounded motion estimate. In particular, filtering in the lateral direction is shown to preserve delay estimation accuracy in the filtered sub-bands while creating decorrelation between sub-bands at the expense of some lateral resolution. For Gaussian anodization, they explicitly compute the induced signal decorrelation produced by Gabor filters. Furthermore, it is shown that lateral filtering is approximately equivalent to steering, in which filtered sub-bands correspond to signals extracted from shifted sub-apertures.

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Sara Parrilli et al (2012) proposed a de-speckling algorithm for synthetic aperture radar (SAR) images based on the concepts of non-local filtering and wavelet-domain shrinkage. It follows the structure of the block matching.

Opretzka et al (2011) proposed a high-frequency (20 MHz) ultrasound imaging system equipped with a spherically focused transducer. Limited-angle spatial compounding is utilized to improve the image contrast, to suppress speckle and noise, and to reduce imaging artefacts. To overcome the limitation in depth of field, the system utilized a novel synthetic aperture focusing technique based on the correlation of the recorded echo signals with the simulated point spread function of the imaging system. This method results in lower side lobe levels and greater noise reduction compared with delay-and-sum focusing, which is demonstrated by wire phantom measurements. They have shown that when this method is used in combination with limited-angle spatial compounding, the resulting image quality is superior to conventional single-element HFUS imaging systems and to array systems.

III. WAVELET FAMILIES

3.1 Discrete Wavelet Transform

The discrete wavelet transform (DWT) was developed to apply the wavelet transform to the digital form The discrete wavelet transform (DWT) refers to wavelet transforms in which sampling of wavelet is done in a discrete way it has variable window size therefore scaling can be done in this and computation time is less The 2-D wavelet decomposition is performed by applying 1-D DWT along the rows after that apply 1-D DWT along columns This operation results in four decomposed sub-band images referred to as low low (LL), low high (LH), high low (HL), and high high (HH).

For multi resolution analysis, the LL band of previous level is again decomposed by DWT where L is low frequency band, H is high frequency band and 1,2,3 are the decomposition levels.

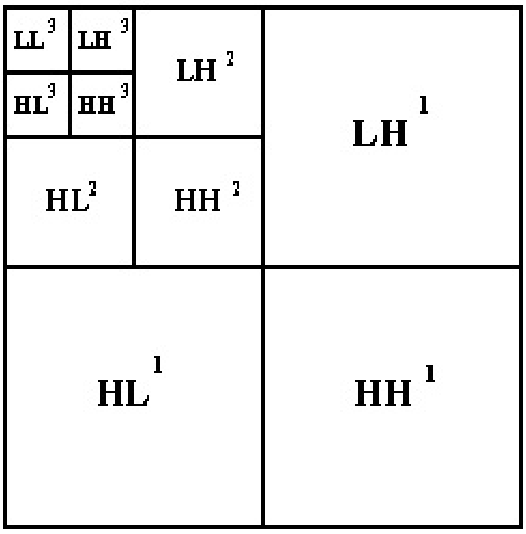

Fig. 2 Structures of 2-D DWT with 3 decomposition levels

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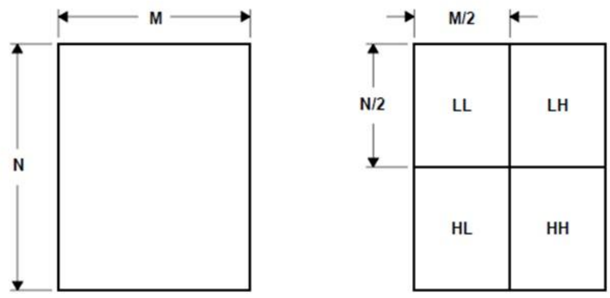

Fig. 3 Original Image One-level 2-D Decomposition

3.2 Haar Wavelet

In mathematics, the Haar wavelet is a sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. The Haar wavelet was invented by Alfred Haar in 1909.

It is the simplest wavelet and its operation is also easy to understand. The Haar sequence is now recognised as the first known wavelet basis it is very fast and memory efficient. It is exactly reversible without the edge effects that are a problem with other wavelet transforms.

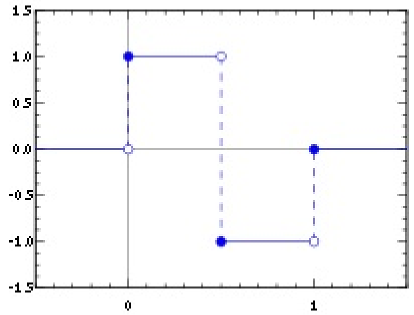

Fig. 4 Haar Representation

3.3. Symlet Wavelet

They are a modified version of Daubechies wavelet with increased symmetry. The properties of the Daubechies and Symlet wavelet families are similar. There are 7 different Symlet functions from sym2 to sym8. In symN, N is the order. Symlet are symmetrical wavelets.

They are designed so that they have the least asymmetry and maximum number of vanishing moments for a given compact support.

IV. IMAGE DE-NOISING METHODS

4.1 Median Filter

Which is used to remove speckle noise, pulse noise or spike noise from the image, Median filter is the special smoothing filter which improves the result of later processing by removing noise from the signal and preserves the edges. The median filter plays important role in image process and visualization.

The median filter implementation consists of calculating the median of the grey level values among the square or rectangular filter window surrounding every pixel. And arranges all the grey level values within the ascending order and selects the middle value and replaces the middle pixel of that set.

4.2 Weiner Filter

Wiener filter is a linear filter. It adjust local variance Wiener filter performs small smoothing for high variance. For low variance perform lot of smoothing. It requires a lot of computation time

V. METHODOLOGY

- Pre-processing
- Noise Generation
- Filtering
- Wavelet Transform
- Quality Measurement (MSE, PSNR and Processing time)

Wiener filter is an effective and efficient method to reduce the speckle noise having minimum mean square error have been pre-estimated Various methods are available for image denoising of ultrasound images which are corrupted by speckle noise includes filtering techniques like wiener filters, median filter, adaptive filtering techniques and transform based techniques including Fourier transform, Hilbert transform and wavelet transform techniques. Speckle noise is a high frequency content present in ultrasound images. When multiplicative noise such as Speckle noise is concerned it is better to use the best effective method for reduction of speckle noise Discrete wavelet transform in which as it has variable window size and wavelet decomposition is done in it and it is effectively used to separate the noise content from original image Median filter is used to preserve edges of the image in order to sharpen it and wiener filter is used as it tailors itself to local variance and perform smoothing.

5.1. Measurement Metric

Mean Square Error (MSE) The MSE represents the cumulative squared error between the compressed and the original image, Mathematically MSE is given by the equation shown below:

$$MSE= \sum M, N\, [I_1 (m, n)-I_2 (m, n)]^2 /(M*N)$$

PSNR is the ratio between the maximum possible power of signal and the power of corrupting noise that affects the fidelity of its representation. The PSNR measure is given by:

$$PSNR=10 \log_{10}(\frac{R^2}{MSE})$$

The higher the PSNR, the better the quality of the compressed, or reconstructed image The PSNR block computes the peak signal-to-noise ratio, in decibels, between two images.

VI. EXPERIMENTAL RESULT

First speckle noise is added and then filters are applied to reduce noise at some extant than three level DWT is applied in wavelet domain and IDWT (inverse discrete wavelet transform) is applied to get original image back.

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Fig. 5 Original Ultrasound Image & Image Corrupted with Noise

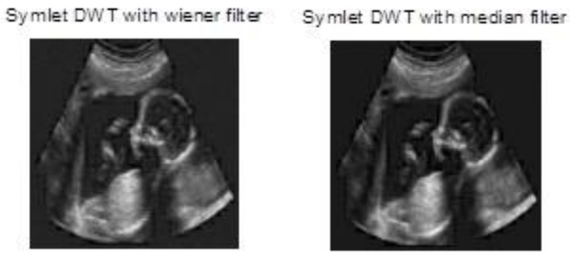

Fig. 6 Restored image with Symlet DWT after Wiener filter & after Median filter

Fig. 7 Restored image with Haar DWT after Wiener filter & after Median filter

To estimate the performance of the Symlet and Haar wavelet with wiener and median filters, various statistical values have been calculated from the original, noised and de-noised Ultrasound image like MSE, PSNR and processing time.

TABLE 1 EXPERIMENTAL RESULT

Algorithm	MSE	PSNR	Processing time
Image corrupted with speckle noise	22.9829	34.5167	0.1338
Symlet DWT with wiener filter	4.70491	41.4052	0.3593
Symlet DWT with median filter	0.0227	64.552	0.6694
Haar DWT with wiener filter	4.7281	41.3838	0.3576
Haar DWT with median filter	0.0234	64.4203	0.6629

VII. CONCLUSION

Median and wiener filter along with Haar and Symlet DWT approach are analysed and their comparative analysis is done Ultrasound image corrupted with speckle noise is compared with denoised Ultrasound image achieved by various techniques DWT is applied and after multilevel decomposition and filtering, finally reconstruction image will be achieved.

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