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Research Paper

Speckle Noise Reduction in Biomedical Images Using Haar Wavelets with Wiener Filter

Engineering

KEYWORDS : Ultrasound, Speckle, DWT, Haar wavelet, Wiener filter, Mean square error.

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ABSTRACT

Removing a speckle noise from medical images is an important task diagnosis. Various filtering techniques like mean, median, kaun have been developed but they give only little improvement. Latest domain in the field of Image denoising and compression is using wavelet analysis. Multiresolutional image analysis using wavelets is the latest modification in the field of image enhancement and denoising. So in this paper we use wavelet function haar wavelet with wiener filter and results are obtained using MSE (Mean Square Error), Elapsed time, using PSF and at the end we get denoised image.

Introduction

The biomedical images generated using ultrasound is poorer than other medical imaging systems like MRI, CT scan etc. But, these images are non-invasive, portable, accurate, harmless to the patient and less costly. These features make the Ultrasound imaging the most commonly used medical diagnostic tool in hospitals [14]. But the main disadvantage of the Ultrasound image is its poor quality of which is affected by speckle noise. Speckle is a form of multiplicative noise which degrades the fine details and limits the contrast resolution by making it difficult to detect small and low contrast lesions. Noise is introduced at all the stages of image acquisition due to loss of proper contact between body and transducer probe [1]. The texture of speckle contains important information about the tissues being imaged[14]. Various speckle reduction techniques have been developed like filters but these remove important information along with the noise and give slight improvement. In this we use discrete wavelet transform technique like haar wavelet with wiener filter which provide better results.

Discrete wavelet transform

Wavelet analysis represents the next logical step: a windowing technique with variable-sized regions. Wavelet analysis allows the use of long time intervals where we want more precise low-frequency information, and shorter regions where we want high-frequency information.

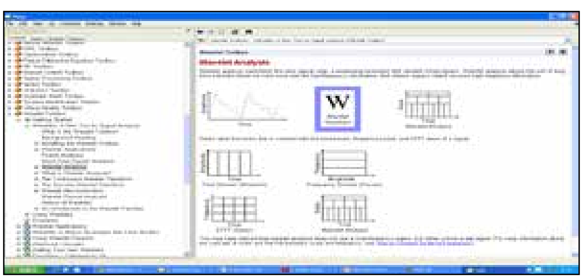

Figure 1: Wavelet Transform on a signal

The discrete wavelet transform (DWT) refers to wavelet transforms for which the wavelets are discretely sampled. A transform which localizes a function both in space and scaling and has some desirable properties compared to the Fourier transform. The transform is based on a wavelet matrix, which can be computed more quickly than the analogous Fourier matrix. Most notably, the discrete wavelet transform is used for signal coding, where the properties of the transform are exploited to represent a discrete signal in a more redundant form, often as a preconditioning for data compression.

The decomposition process can be iterated, with successive approximations being decomposed in turn, so that one signal is broken down into many lower resolution components. This is called the wavelet decomposition tree.

Techniques Used for Speckle Reduction

HAAR WAVELET: The Haar wavelet was proposed in 1909 by Alfréd Haar. It is the simplest of all wavelets and its operation is easy to understand. Haar wavelets have their limitations too. They are piecewise constant and produce irregular, blocky approximations. Haar wavelet is discontinuous, and resembles a step function. It represents the same wavelet as Daubechies db1 [14].

Advantages of haar wavelet transform:

It is simple.
It is fast
It is memory efficient

The disadvantage of the Haar wavelet is that it is not continuous, and therefore not differentiable. This property can, however, be an advantage for the analysis of signals with sudden transitions, such as monitoring of tool failure in machines.

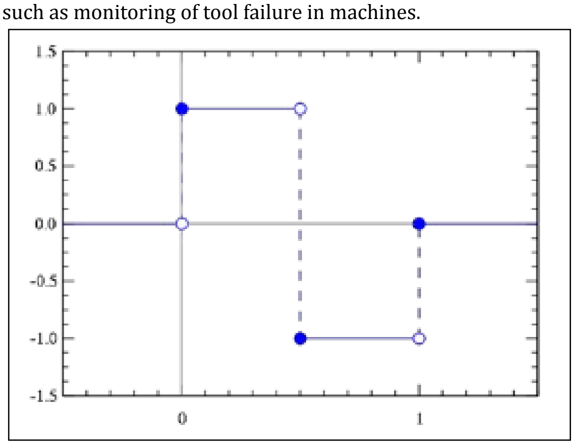

Figure2. Haar wavelet transform

Wiener Filter: In signal processing, the Wiener filter is a filter proposed by Norbert Wiener during the 1940s.It is used to produce an estimate of a desired or target random process by filtering another random process through the filter. The wiener filter minimizes the mean square error between the estimated random process and the desired process. The inverse filtering is a restoration technique for deconvolution, i.e., when the image is blurred by a known lowpass filter, it is possible to recover the image by inverse filtering or generalized inverse filtering. However, inverse filtering is very sensitive to additive noise. The Wiener filtering executes an optimal tradeoff between inverse filtering and noise smoothing. It removes the additive noise and inverts the blurring simultaneously. The Wiener filtering is optimal in terms of the mean square error. In other words, it minimizes the overall mean square error in the process of inverse filtering and noise smoothing. The Wiener filtering is a linear estimation of the original image [14].

Proposed Algorithm

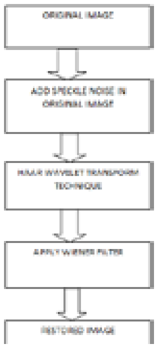

Figure 3 Flowchart of speckle reduction technique using haar wavelet with wiener filter

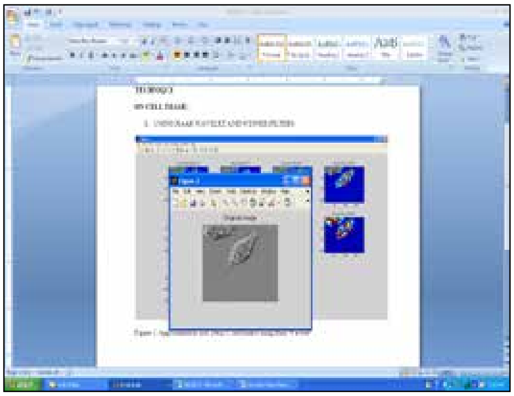

Figure4 Original Image

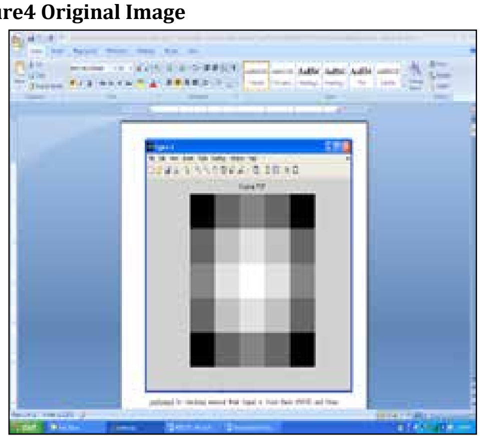

Figure5 PSF (Point Spread Function) of Original Image

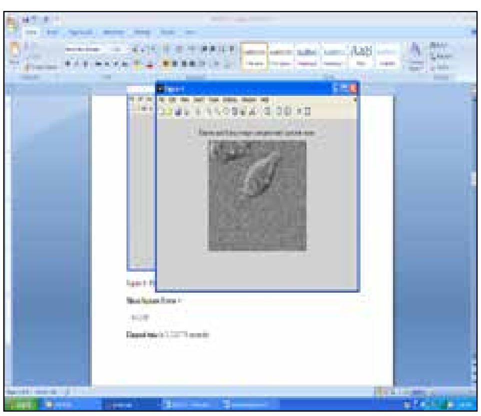

Figure6 Blurred and Noisy Image with multiplicative speckle Noise

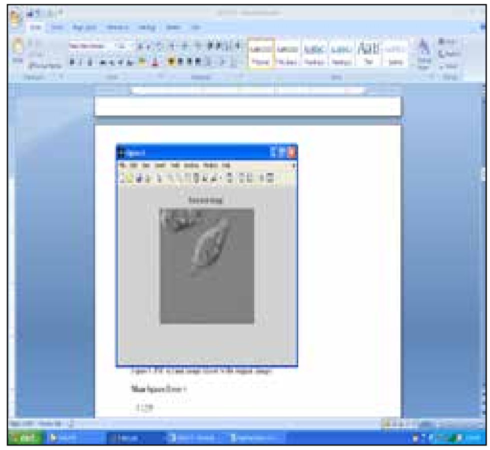

Figure7 Enhanced and Restored Image using Weiner filters and Haar wavelet

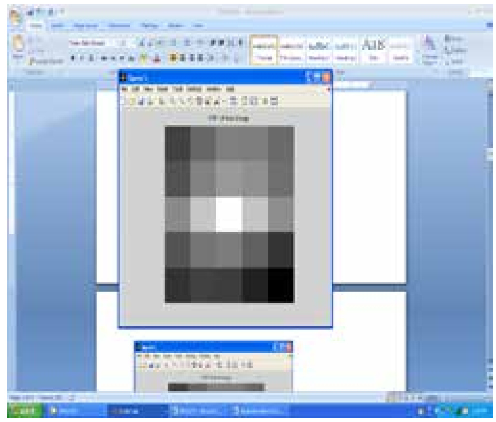

Figure8 PSF of Final Image (closer to the original Image)

Results

In this section we present the values of Mean Square Error and Elapsed time of the restored image obtained after applying haar wavelet with wiener filter on cell image. In this level of decomposition is 3.

	MEAN SQUARE ERROR	ELAPSED TIME
HAAR WAVELET WITH WIENER FILTER ON CELL IMAGE	0.1259	5.224779 Seconds

Table 1: VALUES OF MSE AND ELAPSED TIME

Conclusion and Future Scope

In this paper we conclude that haar wavelet with wiener filter provide better results than previous filtering techniques. The point spread function (PSF) of restored image is closer to original image that means speckle noise is removed. This technique is also used for other types of images like MRI, CT scan etc. We can also use symlets wavelets, coiflets wavelet and other wavelets to remove speckle noise.

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