Effective Noise Reduction Techniques for Despeckling Ultrasound Medical Images

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Abstract - Image processing plays a vital role in the development of medical industry especially ultrasound medical images. Ultrasound notion is simply denoted by means of the signal unit as millions of hertz's. The speckle noise can occurred in during the processing of image acquisition or restoration. If speckle noise is occurred in the medical images it might be less quality and affects the physician's interpretation. Since speckle is a random, deterministic and interference pattern of an image form with coherence; so the brightness of the image might be scattered. Hence removing speckle noise in ultrasound images is an important and also challenging one. Filtering is one of the main pre-processing techniques in digital image processing techniques characterized by the fact that both its input and output are images. The main purpose of using filtering techniques is blurring and noise removal in the original images but commonly each filtering techniques has its own assumptions, drawbacks and benefits. Hence this paper proposes the comparative study of various filtering techniques like Weiner filter, Bayes wavelet filtering and Morphological filtering method offer an effective denoised medical images to the practitioner. Ultimately, the quality of enhanced image is measured by the statistical quantity parameters like PSNR (Peak Signal to Noise Ratio) , RMSE (Root Mean Square Error) and ENL (Equal Number of Look).

Keywords - *Ultrasonic image processing, Speckle noise, Wavelet filtering techniques, Morphological filtering and PSN.R.*

I. INTRODUCTION

One of the most commercially successful application area of image processing is medical industry particularly ultrasound images. Ultrasound most widely used as diagnostic tools in developed medicine industry because it is inexpensive and portable when compared with other imaging techniques like MRI and CT.The ultrasound provides live images, where the operator can select the most useful section for diagnosing. The ultrasound referred as studying the function of moving structure in real world; the familiar application of ultrasound is obstetrics. Obstetrics is nothing but studying unborn babies are imaged to decide their body development and health conditions [1]. And also determine the unborn baby is male or female. Some other application areas are like heart, breast, muscles, tendons, abdominal organs and arteries etc. Ultrasound images are generated as the ultrasound system transmits high frequency sound pulses into the body . The sound waves travel into the body and hit a boundary between tissues; The reflected waves are picked up by the probe and relayed to the computer and the machine calculates the distance from the probe to the tissues or organ boundaries using the sound in tissue and the time of the each echo's return[2,6]. The system displays the distances and intensities of the echoes on the screen forming a two dimensional image.

Here, the speckle noise may occur in the processing of image scanning (or) playback operation (or) recording. It affects the physician's interpretation like smoothing the texture may be less desirable one .The term speckle noise defined as texture and may possibly contain useful diagnostic information [3]. This complex speckle noise is define by the standard deviation (z) as the corrupted pixels are either set of maximum value, which is something have single bits flipped over the data dropouts noise [4] is referred by

$$f(z) = \frac{g \propto -1}{(\propto -1)!\, a \propto} e^{g/a} \_\_\_\_\_\_\_ (1)$$

Z is referred as gray level of an image and it measured the quality of an image [10, 11]. The main objective of this study is investigating the performance of various filtering techniques like weiner filtering, bayes wavelet filtering and Morphological filtering techniques for making denoised image from the original scene.

This paper is organized as follows Section2 despeckled ultrasound images from efficient filtering techniques. In section3 parameters assessment and performance comparisons are provided and Section4 conclusion drawn by the filtering performance.

II. DESPECKLED ULTRASOUND IMAGES FROM EFFICIENT FILTERING TECHNIQUES

A. Bayes wavelet filtering

If either small or large objects (or) low and high contrast objects are present simultaneously; it can be advantageous of using wavelet for several resolution purpose like multiresoultion, sparsity, edge detection and edge clustering[15]. The wavelet thresholding procedure is the widespread method for denoised wavelet filtering. That wavelet filters are well performed by using wavelet thresholding functions [5, 6, 8]. The basic approach is to compute the two dimensional wavelet the general wavelet based procedure is Choose a wavelet and number of levels or scales for the decomposition and threshold the detail coefficient is select and applies a threshold to the detail coefficient and it accomplished by hard or soft thresholding.

Perform a wavelet reconstruction based on the original approximation coefficients to the modified detail coefficient. Where $\sigma 2$ is the noise variance, σx is the signal standard deviation and β is shape parameters bayes wavelet filter T is expresses [9] as

$$T = \beta\, (\sigma^2 | \sigma_x) \_\_\_\_\_\_\_\_\_\_\_ (2)$$

B. Wiener Filter

The method is founded on considering images and noise as random processes and the objective is to find an estimate of the uncorrupted image f such that the mean square error between them is minimized [9,12,16]. This error measure is given by

$$e^2 = E\{(f - \hat{f})^2\} \quad \text{----------} \ (3)$$

Where E {} is the expected value of the argument Weiner Filter. Weiner filter is otherwise known as Least Mean Square filter

C. Morphological Filter

The language of mathematical morphology is set theory. As such, morphology offers a unified and powerful approach to numerous image processing problem on the whole speckle noise reduction from ultrasound medical images [1,17]. One way to achieve denoised medical images is to perform a morphological filtering via opening following closing. The net result of these two operations is to remove noise.

The expressions for opening and closing of gray scale images have the same form as their counterparts. The opening of image by sub image b denoted f•b is

$$f \bullet b = (f-b) + b \quad \_\_\_\_\_\_\_\_\_\_\_\_ (4)$$

Opening is simply the erision of f by b, followed by a dilation of the result by b.

$$f * b = (f + b) - b \quad \_\_\_\_\_\_\_\_\_\_\_\_ (5)$$

Similarly the closing of f by b denoted f*b is

$$-(f * b) = (-f \bullet \hat{b}) \quad \_\_\_\_\_\_\_\_\_ (6)$$

III. PARAMETER ASSESSMENT

The following metrics are used for measured the quality of the denoised images like RMSE, PSNR and ENL. Root Mean Square Error (RMSE): It is used to find the total amount of difference between two images. It indicates average difference between original and denoised image.

$$RMSE = \sqrt{\frac{\Sigma(f(i,j) - g(i,j))^2}{mn}} \quad \_\_\_\_\_\_\_\_\_ (7)$$

Here f (i, j) is the original image g (i, j) is an enhanced image and m, n are the total number of pixels in horizontal and vertical dimensional of the image.

Peak Signal-to-Noise Ratio (PSNR): It is an assessment parameter to measure the performance of the speckle noise removal.

$$PSNR = 20\log_{10} {}^{255}/_{RSME} \text{ ____ } (8)$$

Equivalent Numbers of Looks (ENL): One of the good approaches of estimating speckle noise level is to measure ENL over a uniform image region. Larger value of ENL corresponds to better suppression of speckle. The value of ENL also depends on the size of the tested region; theoretically a larger region will produces a higher

ENL value than over a smaller region. Formula for the ENL calculation is

$$ENL = \frac{(NMV)^2}{(NSD)^2} \text{ __________ } (9)$$

Where NMV, NSD are Noise mean Value, Noise Standard Deviation respectively where

$$NMV = \frac{\sum_{r,c} I_d\,(r,c)}{R*C} \text{ _______ } (10)$$

NSD is calculated by

$$NV = \frac{\sum_{r,c}(I_d\,(r,c)-NMV)^2}{R*C} \text{ ____ } (11)$$

$$NSD = \sqrt{NV} \text{ __________ } (12)$$

The image to evaluate despeckles filtering in medical ultrasound imaging. All the three filtering techniques, namely, Bayes filter, Weiner filter and Morphological filter are gave significant results at the same time the filters show the similar performance in removing the speckle .Weiner filter used to finding the coefficients that relate to producing the least mean squares of the error signal compared to the Bayes wavelet filter it exhibits extremely less convergence together with it comes at the cost of high computational complexity.

But it does not. This problem is overcome by the Bayes filter gives better presentation because of it Characteristic to be preserved edge sharpness and sub band adaptive for signal .Hence it adapts well to sharp discontinuities in the signal and as long as better denoised images. Morphological filters gives best denoised image providing as the positive elements of the residue are put in an array and each array is calculated by the second order gray level distribution..

Table 1: PSNR Value for Various Filtering Techniques

Filter name	RMSE	PSNR
Weiner Filter	2.31	30.27
Bayes Wavelet Filter	1.84	32.25
Morphological Filter	0.95	48.71

Table 1 show the performance of various filtering for ultrasound medical image noise reduction depends on the statistical quantity parameter PSN and RMSE.

Table 2: ENL Value Table

Filter name	ENL
Morphological Filter	31.00
Bayes Filter	23.31
Weiner Filter	17.66

Table 2 shows the performance comparison of various speckle filters for ultrasound image in terms of ENL.

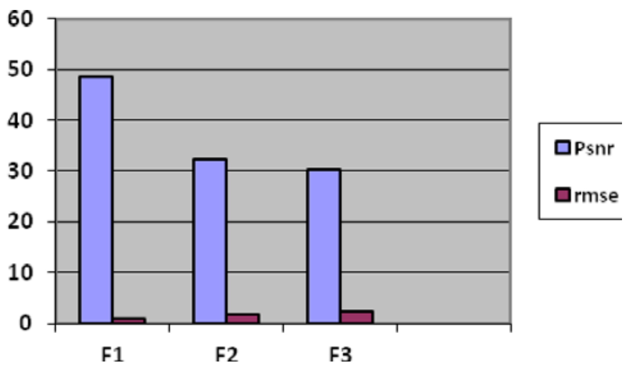

Figure 1: Filter Performance Chart FOR PSNR

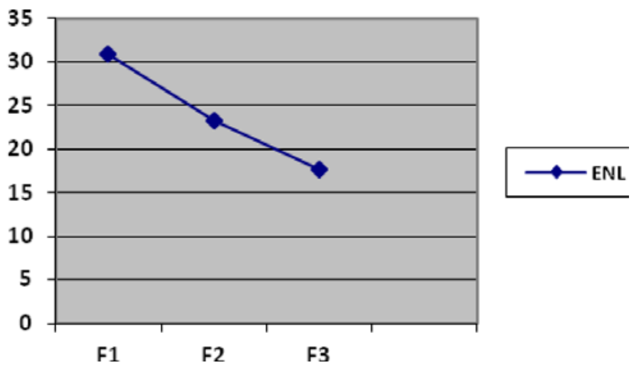

Figure 2: Filter Performance Chart FOR ENL

Figure 1 & 2 Shows the Comparison Chart of ENL Noise variance of different denoising methods for Ultrasound Image

Noised Image

Weiner filter

Bayes Wavelet filter

Morphological Filter

Figure 3: Output Images of the various Filters

IV.CONCLUSIONS

In this paper investigated the performance of various despeckling filtering techniques like Weiner Filter, Bayes Filter, and Morphological Filter. The quality of denoised image is measured by the statistical quantity parameters PSNR, RMSE and ENL. Those filters are based on the second order derivational statistical method of low and high pass filtering. However Bayes wavelet filters gives better performance comparing than the weiner filters since it attempt to reform a despeckled image in the form producing an artifact around the object via the neighborhood of bright edges. But morphological filter perform well comparing with other filters like Bayes and weiner filter while the positive elements of the residue are put in an array and each array is calculated by the second order gray level distribution. Hence, it concludes the Morphological filter is better one from the all other let filters.

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