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Enhanced Techniques for Sequential Hybrid Filtering Method of Despeckling Ultra Sound Images to Reduce Noise

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Abstract- Speckle noise of the images with dark and bright spots, and it degrades the image quality as well as denoising fine edge details of the images. Ultrasound imaging is used for medical field due to non-invasive nature, inexpensive and capability of forming real time imaging. The proposed paper was introduced new enhanced techniques to reduce speckle noise and which degrades the quality of images. The purpose of despeckling is to remove the noise, retaining the edges and other detailed features as much as possible. The proposed method use some of the filtering techniques used in smoothing or suppression of speckle noise and edge preservation in ultrasound images. The main key point of effective speckle removal is balanced between speckle suppression and features preservation which is achieved by using hybrid filtering techniques. Such as Average filter, median filter, Wiener filter, wavelet, Ideal, Butterworth filter and Homomorphism combination of filters are used. Here Peak Signal to Noise Ratio is used as a major measuring tool for indicating the level of performance obtained through the filtering algorithm. In these techniques, merging two or more optimization techniques into a single algorithm is done. Image denoising is an important pre-processing task, before further processing of image like segmentation, feature extraction etc. In this work investigates some of the spatial and transforms domain filtering techniques used in smoothing or suppression of speckle noise and edge preservation in ultrasound images.

Keywords- Average, Median, Wiener, Ideal, Butterworth, Homomorphism filters and Wavelet.

I. INTRODUCTION

An image may be defined as a two dimensional function f(x, y), where x and y are spatial (plane) coordinates and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point, where x, y and the intensity values of f are all finite, discrete quantities, this image is called as digital image. The digital image processing encompasses a wide and varied field of application.

There are three types of image processing

1. Low level processing
2. Mid-level processing
3. Higher level processing

1. Low Level Processing

It involves primitive operations such as image pre-processing to reduce noise, contrast enhancement and image sharpening. A low level process is characterized by the fact that both its inputs and outputs are images.

2. Mid Level Processing

It involves tasks such as segmentation, description of those objects to reduce them to a form suitable for computer processing and classification (recognition) of individual objects. A mid-level process is characterized by the fact that its inputs generally are images but their outputs are attributes extracted from those images.

3. High Level Processing

It involves making sense of an ensemble of recognized objects, as in image analysis, performing cognitive functions normally associated with vision.

a) Digital Image Processing In Ultrasound Images

There are two basic models for noise behavior. The first, additive noise is generally more common. It is independent of image data - thermal noise and noise caused by quantization are common examples. Secondly, multiplicative noise is related to image data and is often found in coherent imaging systems (such as ultrasound).

b) Speckle Noise

Speckle is not a noise but noise like variation in contrast. It arises from random variation in the strength of the backscattered waves from objects and is seen mostly in RADAR and ultrasound imaging.

Speckle noise is defined as multiplicative noise, having a granular pattern it is the inherent property of ultrasound images. Speckle noise degrades the fine details and edge definition and limits the contrast resolution by making it difficult to detect small and low contrast lesion in body.

c) Need For Despeckling

Speckle degrades the quality of ultrasound images and thereby reducing the ability of a human observer to discriminate the fine details of diagnostic examination. Thus despeckling improves human interpretation of ultrasound images. Speckle reduction makes an ultrasound image cleaner with clearer boundaries. The despeckling is a pre-process step for many US image processing task such as segmentation and registration. Speckle reduction improves the speed accuracy of post processing.

II. PROPOSED SYSTEM

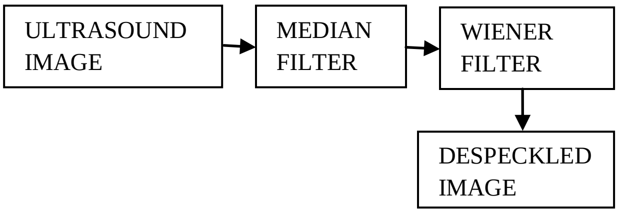


Fig: 1 Proposed System Architecture

Image denoising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. This work describes different methodologies for noise reduction (or denoising) giving an insight as to which algorithm should be used to find the most reliable estimate of the original image data given its degraded version. In the proposed system, hybridization of various filtering technique are done to achieve optimal results. In these techniques, merging two or more optimization techniques into a single algorithm is done.

A. Sequential Hybridization

In sequential hybridization, we have a series of methods where the output of one will be the input of the next one. Several sequential combination of above mentioned filters are experimented.

1. It creates balance between speckle suppression and edge preservation.
2. It provides clear and better ultrasound images

III. EXPERIMENTS DESIGN

The size of mask must be odd (i.e. 3×3, 5×5 etc.) to ensure it has a center. Neighborhood processing consist of

1. Selecting a center pixel (x, y).
2. Performing an operation that involves only the pixels in a predefined Neighborhood about (x, y).
3. Letting the result of that operation be the "response" of the process at that point.
4. Repeat the process for every point in the image. The process of moving the Center point creates new neighborhood, one for each pixel in the input image.

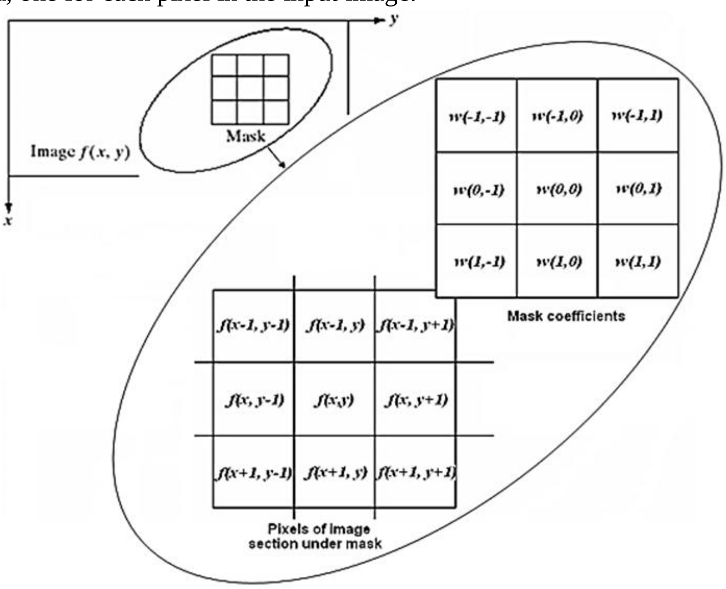
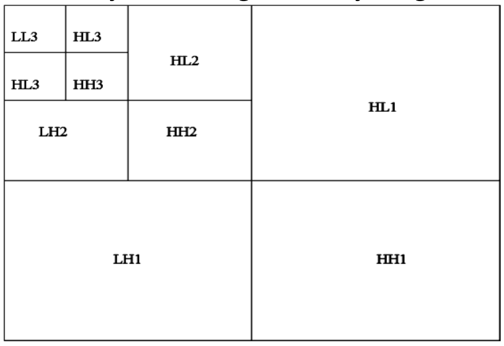


Fig: 2 Experiments Design

A. Algorithm For Wavelet Filtering

Step 1: Read the input image
Step 2: Preprocess the input image
Step 3: Apply Discrete Wavelet Transform
- Get the wavelet name
- Get the level of decomposition required
- Get the band to be eliminated

Step 4: Since we know that when an image is decomposed the HH, LH and HL images contain most of the image's high frequencies and noise, we can eliminate noise by eliminating those very images



Bands to be eliminated
HL
LH
HH
HL-LH or LH-HL
HL-HH or HH-HL
LH-HH or HH-LH
LH-HL-HH

Step 5: To eliminate a particular band, get the size of that band
Step 6: Eliminate the band by making them zero
Step 7: Take Inverse Discrete Wavelet Transform.

B. Algorithm For Ideal And Butterworth Filter

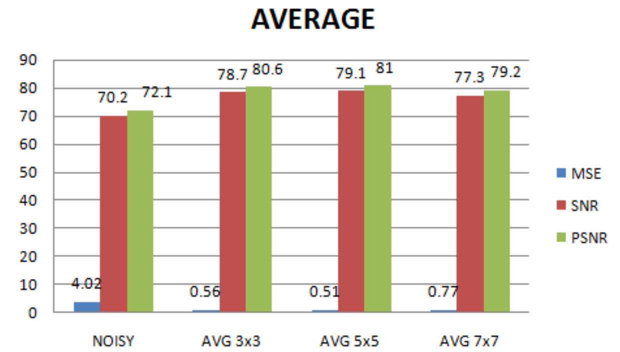
Step 1: Read the input image
Step 2: Determine the size of the input image
Step 3: Check whether the image is colour image or gray scale image if it is colour image then convert to gray scale image.
Step 4: Obtain padding
Reason: when we consider Fourier transform, the images and transforms are periodic. Periodic function can cause interference between adjacent periods, this will lead to wraparound error. To avoid wraparound error, we go for padding.
Step 5: Rearrange the data –visualization purpose.
Step 6: Apply FFT to the preprocessed image
Step 7: Get the cutoff frequency Do
Step 8: TRANSFER FUNCTION-IDEAL FILTER
H(u,v) = { 1 if D(u,v) <= D0
0 if D (u,v) > D0
Step 9: TRANSFER FUNCTION–BUTTERWORTH FILTER

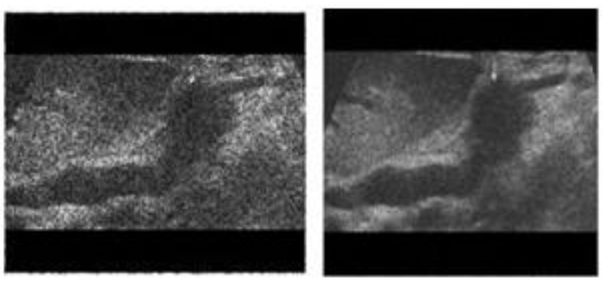
$$H(u,v) = \frac{1}{1 + [D(u,v)/Do]^{2n}}$$

Step 10: FILTER FUNCTION
Multiply the transfer function, Fourier transformed image
Step 11: Take inverse Fourier transform
Step 12: Obtain real part of the result.

IV. PERFORMANCE EVALUATION

A. Mean Filter



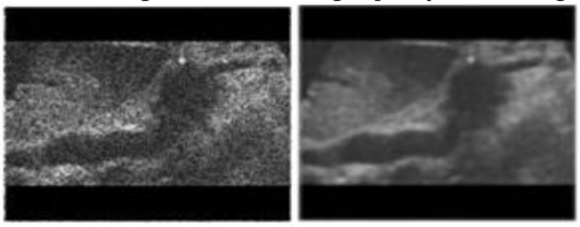


a) Noisy image **b) 3 x 3 windows -Mean**

Fig: 3 Comparisons of MSE, SNR, PSNR Using Mean Filter

B. Butterworth Filter

The Butterworth filter tries to smooth this cutoff and eliminates the Gibbs effect and excessive minimizing of high frequency image details at the expense of losing noise eliminating capacity eliminating capacity.



a) Noisy filter **b) Fc = 30**

C. Wavelet Filter

Eliminate bands in a single decomposition level with at least one high frequency component (HL, LH and HH). Theoretically these bands contain more noise, specially band HH.

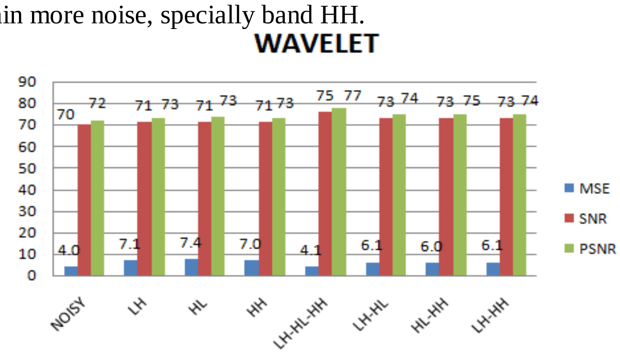
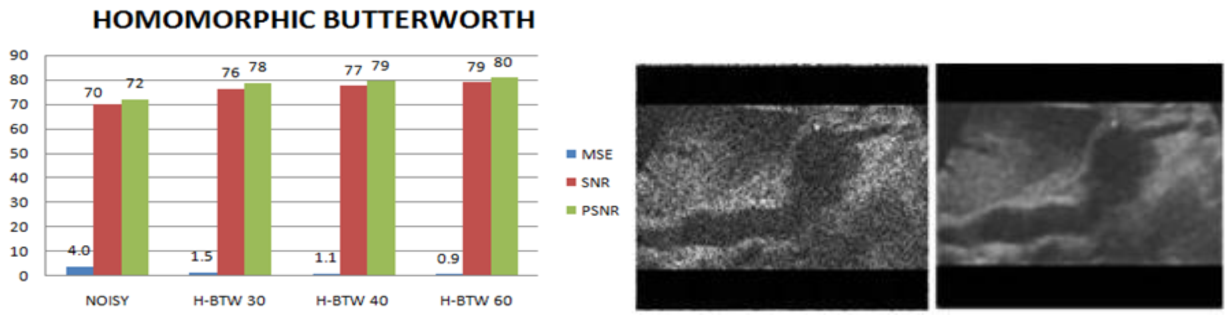


Fig: 4 Comparisons of MSE, SNR, PSNR Using Wavelet Filter

D. Homomorphic Butterworth

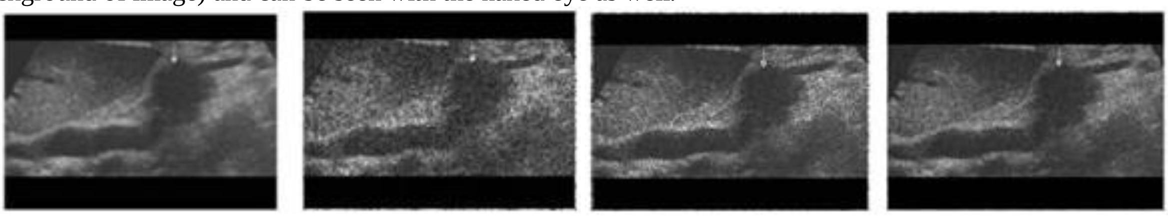


a) Noisy filter **b) Fc = 30**

Fig: 5 Comparisons of MSE, SNR, and PSNR Using homomorphic Butterworth filter

E. Wiener Filter

Wiener filtering preserved the edges reasonably well, but in this case the noise elements are visible (clearly visible on the background of image) and can be seen with the naked eye as well.



a) Original image **b) Noisy Image** **C) Wiener Filter** **d) Homomorphic Wiener**

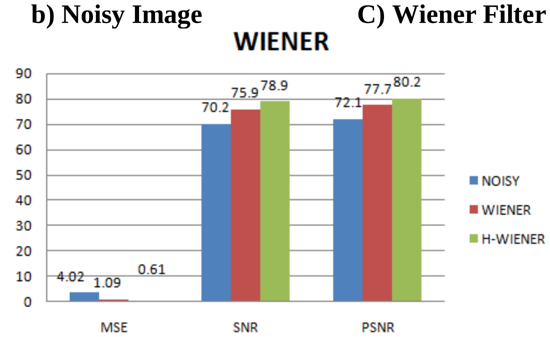


Fig: 6 Comparison of SNR, MSE, PSNR using homomorphic wiener filter

V. OUTPUT SCREENSHOTS

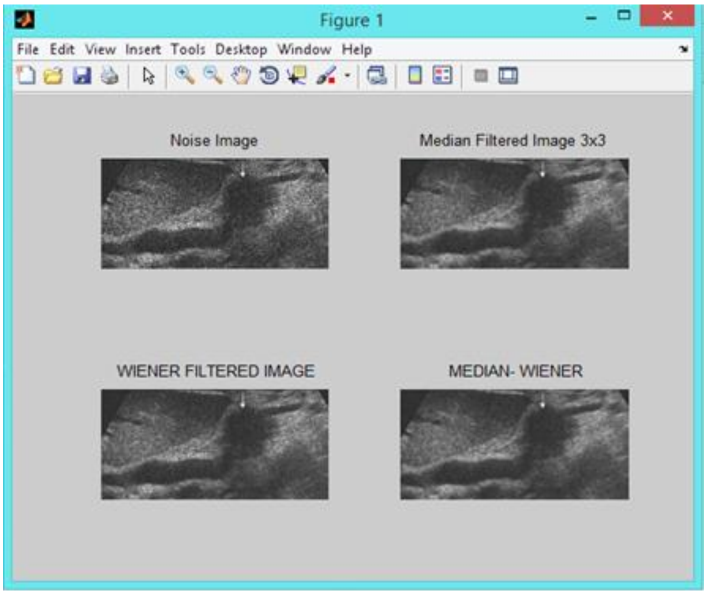


Fig: 7 Output of Median-Wiener Filter

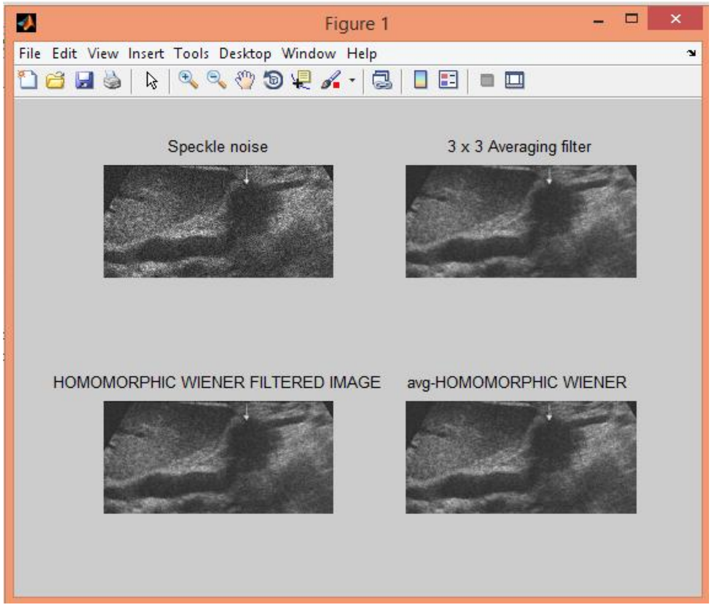


Fig: 8 Output of Average –Homomorphic wiener Filter

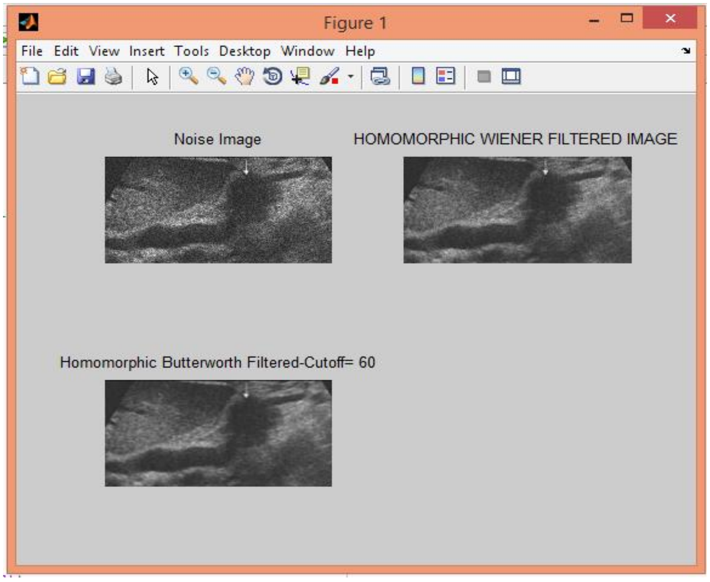


Fig:9 Output of Homomorphic Butterworth filtered –cutoff=60

VI. CONCLUSION AND FUTURE WORK

Ultrasound images often suffer with a special type of noise called speckle. Introduction of speckle degrades the image contrast and block out the under lying anatomy. In order for the medical practitioners to achieve correct diagnosis, the ultrasound images have to be despeckled.The comparison of different filters based on the performance metrics like MSE, SNR and PSNR. When comparing mean and median filter, median filter removes noise effectively and at the same time preserve edges. Among the above used filters, the best qualities of images were obtained with Wiener, Butterworth and Ideal filters. The wavelet filtering as we have seen does not seem recommendable with real ultrasound images. It not only eliminates noise, but when the bands are eliminated, an effect with white dots appears that distorts the image very much. The homomorphic filtering works best for Wiener, ideal, Butterworth filters, however with other filters it is not that useful.

Hybrid combination of filters is designed to improve the performance. A hybrid combination of Butterworth with Wiener, Butterworth with Homomorphic Wiener removes noise effectively than individual filters and also hybrid combination of median with Wiener preserve edges effectively than individual filters. It is anticipated that future work would involve more experimental work with a variety of ultrasound images.

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