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A Comparative analysis of De-noising Techniques in ultrasound B mode images

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Abstract: This paper aims at defining accurate method for denoising of ultrasound B mode images. Denoising is the primary operation in medical image processing to remove the unwanted noise present in the image there by we eliminate redundant data. Here various denoising techniques are compared based on different parameter to obtain accurate results.

Index terms: wavelet, denoising, B mode, ideal.

I. INTRODUCTION

Ultrasound, also called as sonography, uses sound waves to view a part inside the body. A gel is put on the skin of the breast lesion and a handheld instrument called a transducer is moved along with gel and pressed against the skin. It emits sound waves and then picks the echoes as they bounce off body tissues. The echoes are converted by a system into a black and white image on a desktop screen. This test is painless and person is not harmed by radiation. Breast ultrasound is used to evaluate breast lesions that are found during a screening or mammogram or on physical examination. Breast ultrasound is not often used for screening. It have been suggested that it may be helpful to use ultrasound along with a mammogram when screening high risk women with dense breast tissue (which is difficult to evaluate with a mammogram). Always, ultrasounds cannot replace mammograms. More studies are needed to find out if ultrasound should be added to regular screening mammograms for some groups of women. Ultrasound is useful for taking a deeper look at some breast masses, and itsthe way to tell if a suspicious area is a cyst or other lesion without using a needle into it to take out (aspirate) fluid. Breast ultrasound is used to help doctors guide a biopsy needle into an area concerned in the breast.

Ultrasound images often contain speckle noise which reduces the quality of the images. Eliminating speckle noise is an very important pre-processing task. This paper describes and hence analyses an algorithm for removing speckle noise in ultrasound medical images using various kinds of filters. Some Mathematical Morphological operations are used in this algorithm. Generally there is no common noise enhancement approach for noise reduction. Several approaches has been found and each has its own assumptions, merits and demerits This paper analyses different filtering techniques based on statistical methods for the removal of speckle noise. A number of successful experiments validate the suggested filtering model. The quality of the noise removed enhanced images is measured by the statistical quantity measures: Signal-to-Noise Ratio (SNR), Peak Signal-to-Noise Ratio (PSNR), and Mean Square Error (MSE).

ULTRASOUND B MODE

A two-dimensional diagnostic ultrasound idea of echo-producing interfaces; the intensity of the echo is shown by modulation of the brightness of the particular spot, and the position of the echo is found from the angular position of the transducer and the transit time of the acoustic pulse and its echo. These ultrasound B mode scans are always painless and safe. Unlike X-rays and other imaging methods ultrasound do not make use radiations. They have not been found to cause any complications in testing of breast lesions .First, B mode image of the lesion is taken, then which a slight compression is applied.

The effect of breathing and heart beat produce the required compression. The elastogram is generated by the machine by comparing pre compressed and post compressed RF signals and the elastogram is displayed adjacent to the B mode image. The ultrasound B mode and elastograms generated are usually gray scale images.

I. MEDIAN FILTER:

Median filter is a non linear digital filtering technique which is used for noise reduction in image. Itis an algorithm that is useful for the removal of impulse noise. This noise is manifested in a digital image by corruption of the captured image with bright and dark pixels that appears randomly

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throughout the spatial distribution. Impulse noise arises from peaks in the output signal due to external interference or poor sensor configuration. The median filter, when it applied to grayscale images, which is a neighbourhoodbrightness-ranking algorithm that works by first placing the brightness values of the pixels from each neighborhood in ascending order. The median value of this ordered sequence is then selected as the representative brightness value for that neighborhood. Simultaneously, each pixel of the filtered image is defined as the median brightness value of its corresponding neighbourhood in the original image.

II. WAVELET FILTER

Wavelet denoising reduces high frequency noises. A wavelet is an wave-like oscillation with an amplitude that begins at value zero, increases, and then decreases back to zero value a direct wavelet can be computed from original image.

The general wavelet denoising procedure is as follows

• Apply wavelet transform to the noisy signal to produce the noisy wavelet .Coefficients to the level which we can properly distinguish the PD occurrence.

• Select appropriate threshold limit at each level and threshold method (hard or soft thresholding) to best remove the noises.

• Inverse wavelet transforms of the thresholded wavelet coefficients to obtain a denoised signal.

III. HORMOMORPHIC FILTER:

Homomorphic filtering is the technique used for removing multiplicative noise that has certain characteristics.Homomorphic filtering is most commonly used for correcting non-uniform illumination in images. The radiance-reflectance model of image formation says that the intensity at any of the pixel, which is the amount of light reflected by a point on the object, is the product of the illumination of the scene and the reflectance of the object in the image.

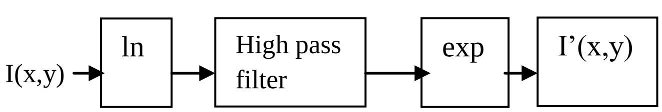

Fig.No.1. Homomorphic filter

In homomorphism filtering first we transform the multiplicative components to additive components by moving to the log domain.

ln (I(x,y))=ln(L(x,y) R(x,y))

ln (I(x,y))=ln(L(x,y))+ln(R(x,y))

Then we use a high-pass filter in the log domain to +remove the low-frequency illumination component while preserving the high-frequency reflectance component. The basic steps in homomorphic filtering are shown above diagram.

IV. BUTTERWORTH FILTER

Butterworth filters are having a property of maximally flat frequency response and no ripples in the pass band. It rolls of towards zero in the stop band. Its response slopes off linearly towards negative infinity on logarithmic Bode plot. Like other filter types which have non-monotonic ripple in the passband or stopband, these filters are having a monotonically changing magnitude function with ω. Butterworth filter has a slower roll off when comparing with chebyshev type I/type II filter or an elliptic filter. Hence for implementing a particular stopband specification it will require a higher order. The response of an n-order Butterworth low pass filter is:

$$R(\omega)=\frac{1}{1+\epsilon^2 C_n^2\left(\frac{\omega}{\omega_c}\right)},$$

Where Єis the ripple, $\omega_c$is the cutoff frequency and $C_n$is the *n*th order Chebyshev polynomial.

V. IDEAL FILTER:

Ideal filters allow a specified frequency range of interest to pass through while attenuating a specified unwanted frequency range .For an ideal filter, the attenuation for frequencies beyond the cut-off would be complete. The ideal filter is impossible to realize without also having signals of infinite extent in time, and so generally needs to be approximated for real ongoing signals, because the sinc function's support region extends to all past and future times. The filter would therefore need to have infinite delay, or knowledge of the infinite future and past, in order to perform the convolution.

VI. HOMOMORPHIC WAVELET

Wavelet transform is an effective tool of multiresolution analysis in spatial and frequency domain. It can decompose signal to a series of signal that has different resolution, frequency property and
Direction. In other words, it has nicer local property, so it has been applied to digital image processing widely In the

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Fourier transform of traditional homomorphic filtering, spatial resolution is lower, and local contrast of image is not increased obviously. Low pass filtering could reduce noise by smoothing, but the border of image will become to more indistinct. High pass filtering could enhance the edge of image, but the noise of background will be increased. On the contrary, the signal of low resolution could be retained absolutely by wavelet transform. While the signal beside the edge will be discerned firstly, and then be also retained. Because the noise of wavelet transform usually concentrates on the state of high resolution, the method above is useful to eliminate the noise in wavelet transform. Furthermore, the signal of edge could retain well. So wavelet transform is an effectual method. In wavelet transform, image is decomposed by the method of discrete two-dimensional wavelet. According to wavelet transform, the part of low frequency can represent the primary visage of image, and the part of high frequency can represent the detail of image. So the overall steps are executed on the image. Its process is shown below

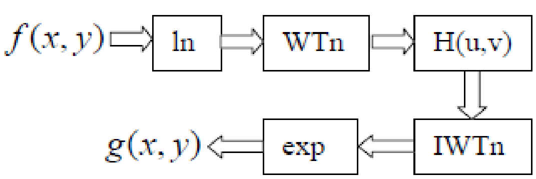

Fig.No.2.Homorphic Wavelet

VII. HOMOMORPHIC BUTTERWORTH

The typical filter for homomorphic filtering process has been introduced. This filter has circularly symmetric curve shape, centred at $(u,v)=(0,0)$ coordinates in frequency domain. This filter is modified from Gaussian high pass filter, which is known as Difference of Gaussian (DoG) filter. The transfer function for DoG filter is defined as

$$H(u,v) = (\gamma_H - \gamma_L)\left[1 - \exp\left\{-c\left(\frac{D(u,v)}{D_0}\right)^2\right\}\right] + \gamma_L$$

Where constant c has been introduced to control the steepness of the slope, $D0$ is the cut-off frequency, $D(u,v)$is the distance between coordinates (u,v) and the centre of frequency at (0,0). For this filter, three important parameters are needed to be set by the user. They are the high frequency gain, the low frequency gain, and the cut-off frequency $D0$.

CHAPTER III

VIII. EXPERIMENTAL RESULTS:

FILTER	MSE	PSNR	SNR
IDEAL	0.010444	67.94229	59.21708
HOMOMORPH	0.010755	67.81453	59.0814
MEDIAN	0.015404	66.25442	57.52921
BUTTERWOR	0.009292	68.44954	59.21708
WAVELET	0.076402	59.29975	50.57454
HOM.BUT	0.008509	68.83178	69.70044
HOM.WAV	0.006329	70.1172	61.39256

Table.No.1.Parameter Comparison

A. MEDIAN FILTER:

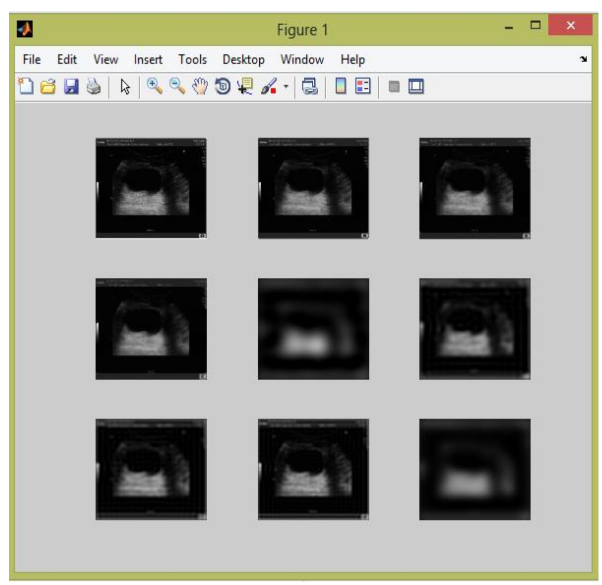

Fig.2. Original image, median filter c=3, 5, 7, other.fourier ideal filter=10, 30, 40, other.

B. BUTTERWORTH FILTER

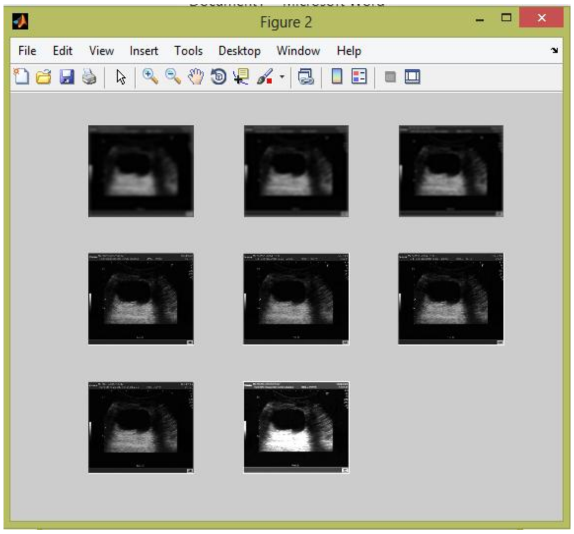

Fig.3.Fourier butterworth filter c=10,30,40,other-Wavelet Single Level Decomposition Filtering c=1,2,3,other

C. HOMOMORPHIC FILTER

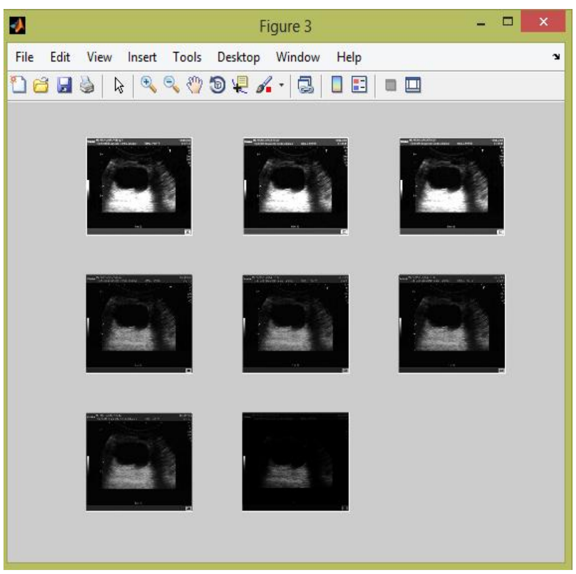

Fig.4. Wavelet Second Level Decomposition Filtering c=1,2,3,other.Homomorphic Wavelet Single Level Filtering c=1,2,3,other.

D.HOMORPHIC IDEAL

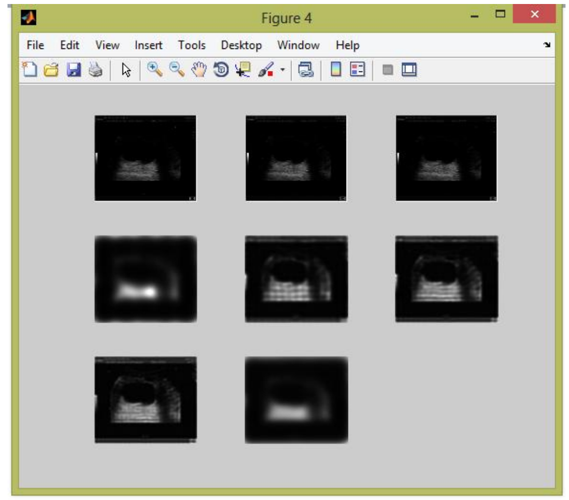

Fig.5. Homomorphic Wavelet Second Level Filtering c=1,2,3,otherHomomorphic Fourier Ideal Filtering c=10,30,40,other

E.HOMORPHIC BUTTERWORTH:

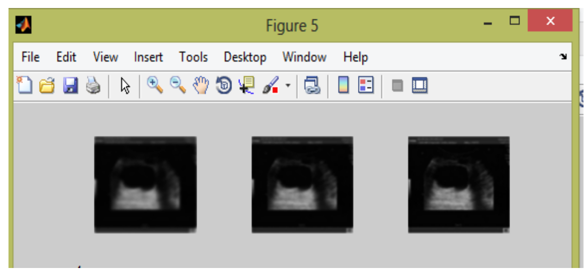

Fig.6. Homomorphic Fourier Butterworth Filtering c=10, 30, 40.

IX. RESULTS AND DISCUSSION

In this paper a comparative analysis on different denoising methods are done. Based on the analysis of different parameter homomorphic butterworth filter shows less MSE value, and high snr and psnr value.It removes speckle noise effectively than other six methods .

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