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Noise Removing in Medical Images by using Image Fusion Method

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Abstract*: *Image processing also made a graph in medical applications. During disease diagnosis medical practitioners are widely using digital images. At several states of art medical equipments are producing images of different organs, which are used at different stages of disease. Such medical images are X-rays, CT scans, MRI, ultrasound images etc. These images are produced by high frequency waves which also contains some part of noise. This noise is generated due to scattering of high frequencies. This noise is called as Speckle. Speckle alters the image quantity hence degrades the information in it which may cause any small error to the practitioner to disease diagnosis. Hence speckle removing made a vital role in medical images. This paper gives detail study of PCA image fusion to remove noise.

***Keywords:** US, SNR, NCD, PSO, PCA.*

I. INTRODUCTION

Medical Imaging is nothing but a visual representation of internal body structures, tissues and organs. Now days image processing is playing a vital role in medical practitioner. MRI, CT scan, Ultrasound images and X-rays are medical images used to disease detection and helps practitioner to recover disease. Ultrasound (US) is nothing but a high frequency sound waves used to characterize different tissues. US have some properties such as compression, reflection, impedance etc. used to identify and characterize different tissues. Due to the random fluctuations of back scattering waves, a noise is generated which is nothing but speckle in ultrasound image. Due to speckle in the images contras resolution get decreased, due to this it is difficult to detect small or low contrast structures to diagnosis. Speckle reduction gives a better denoised image which helps to diagnose disease very easily from denoised image. The main advantage of reducing the speckle is to provide the radiologist with better view of the Ultrasound image through reducing the noise without destroying important features. This paper gives an algorithm for removing noise from digital medical images and comparison of input noisy image to the output denoised image generated by image fusion technique. Ultrasound is nothing but a high frequency waves which are normally higher than those audible humans (>20000 Hz). While taking an ultrasound image frequency pulses are sending into different tissues using a probe. These pulses echoes of tissues are having different reflection properties which are recorded to the other side and displayed as an image. Ultrasound images are carried out by sending a sound wave from the probe at the one end. These sound waves are nothing but high frequencies which get scattered from internal organs, tissues or obstacles. This scattering of wave produces unwanted signal in an image. There are two types of scattering diffusion scattering and coherent scattering. Diffusion scattering are those which are by random phase of scattering. Whereas scattering which are in phase with the ultrasound beam are coherent scattering and causes a dark spot in image. This dark spot, light and out of phase scatters are unwanted signals in an image which are called as Speckle in image. The speckle is nothing but unwanted signals which degrades image quantity. Sometimes these speckles are responsible for loss of information within the image. This loss can make a big problem to radiologist to detect the disease. Speckle reduction gives a better denoised image which helps to diagnose disease very easily from denoised image. The main advantage of reducing the speckle is to give a noise free image to the radiologist for better view image to detect any small kind of issue in the body.

II. MATERIALS AND METHODS

US Images: Ultrasound images are used for medical application to detect any swellings, pain, tumors or any other health issues of internal organs of a human body. The most important use of a ultrasound image is it is widely used for checking all the progress of a fetus in a pregnant woman. It gives all details of fetus with all the body parts like skin, heart, development of brain, liver, lungs, heart beats; even it can detect any kind of issue in the fetus. PCA is the method which gives a fused image without losing any information or data. PCA is a method for simplifying a multidimensional dataset to lower dimensions for analysis, visualization or data compression. PCA represents the data in a new coordinate system in which basis vectors follow modes of greatest variance in data.

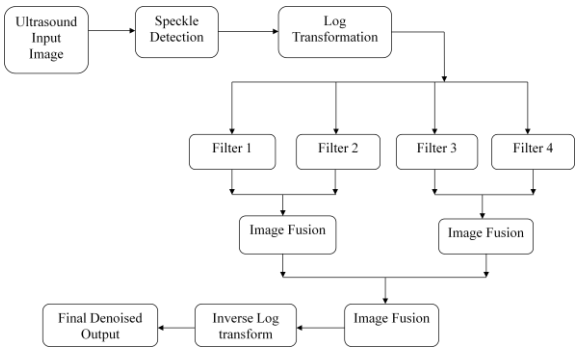

Fig.1 Schematics block diagram of work.

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The above figure shows the proposed system. Input image is loaded in the first stagr of processing. Then preprocessing is carried out by histogram equalization, which transforms lower contrast area to higher contrast area. Speckle noise is multiplicative in nature which has maximum information in it. So it is important to convert multiplicative noise to an additive noise by using log transformation process. Neglecting the additive Gaussian's noise, then we have:

$$f(a, b) = f_0(a, b) . \eta_m(a, b) + \eta_a(a, b)$$

where ,

f(a , b) is noisy image,

f_0 (a , b)noise free image

,η_a(a , b) and η_m (a , b) are additive and multiplicative noise. As additive noise have lower values as compares to multiplicative noise. So ignoring the additive noise we will get the image with speckle noise as expressed,

$$f(a, b) = f_0(a, b) . \eta_m(a, b)$$

Image fusion method is applied on the outputs of filters. PCA technique is used for image fusion, which has the advantage like it reduces complexity in images grouping with the use of PCA algorithm. Due to reduction of noise maximum variations are removed and so the small variations in the background are ignored automatically. Apply the PCA algorithm on outputs of filter1 and filter2 as well as on filter3 and filter4, which gives two image fused outputs. The filters used are Median filter, Lee Filter, Butterworth Filter and Bays Filter. Lee filter is used to for edge preservation as compared to all filters. It is better in edge preservation. Lee filter operates on variance basis, when variance is low it performs the better smoothing operation, but when variance is high it does not perform well. It is in adaptive nature as it preserve in low as well as in high contrast image. This filter reduces speckle noise by applying spatial filter to each pixel. Lee filters are works on colour filters and colour gels for image lighting.

Mathematical model for Lee filter is given in equation,

$$lmg(i, j) = lm + W*(Cp-lm)$$

Median filters are invented in 1990. In median filter centre value of pixel is replaced by the median value among all the pixels. It is a non linear filter. Due to this property it is used to reduce impulse noise in an image.. Bays filters are used for image filtering and smoothing the image. Another version of smoothing/ sharpening filters is the Butterworth filters. An advantage with the Butterworth filter is that we can control the sharpness of the filter with the order. A Butterworth filter of order n and cutoff frequency D0 is defined as,

$$H(u, v) = \frac{1}{1 + [D(u, v)/D_0]^{2n}}.$$

Again apply the PCA algorithm on these two outputs which gives the denoised image. After that perform the log inverse transform and will get the final denoised output with reduced form of speckles as compared to original image.

III. RESULTS AND DISCUSSION

For quality or performance checking of proposed work we are calculation some parameters for comparison. The parameters calculated are Signal to noise ratio, mean square error, structural similarity and power to signal ratio between the input ultrasound image and output denoised image.

A. *Signal to Noise ratio (SNR)*: The signal to noise ratio is often used for indicating the value of noise in an image. If the value of SNR is high then the image is good in quality with low noise and has the more information. Low value of SNR indicates noise in an image. Mathematically expressed as:

$$\text{SNR in dB} = 10 \log_{10} \frac{\sigma^2 f}{\sigma^2 n}$$

B. Mean square error (MSE):

The MSE is used to calculate the noise in an image. The MSE value should be low. For lower value of MSE it gives the better noise free image. As the higher value of MSE indicates the noise in an image and the filter is not in smoothing or noise reducing process.

C. **Structure similarity index measure (SSIM):** The *SSIM OR MISS* gives the structural similarity between two images. It is always in between 0 to 1. Higher the value of SSIM gives the better quality or similarity in an image.

D. Peak signal to noise ratio (PSNR): The *PSNR* is defines as, ratio of the maximum possible powers of a signal to the power of corrupting noise. It is calculated by,

$$\text{PSNR} = 10 \log_{10} \frac{256 \times 256}{MSE}$$

*Result analysis first US images:

TABLE 1: Parameters of input US Image

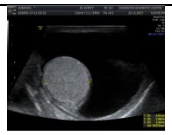
Sr. No.	Parameters of Comparison	Input Image	Output Image
1			
	MSE	0.0547	2.6464e-04
	PSNR	52.6205	75.7734
	SNR	1.0524	1.5155
	SSIM	0.8024	0.9993

TABLE 2: Parameters of output US Image

	Parameters of Comparison	Input Image	Output Image
2			

	MSE	0.1310	4.3643e-04
	PSNR	48.8267	73.6009
	SNR	0.9765	1.4720
	SSIM	0.7365	0.9995

Above tables indicates that all parameters of output images are fulfilling given conditions with respect to the input images.

IV. CONCLUSION

The main aim of proposed work is detection and reducing the noise contained in an ultrasound image. This research paper introduces an algorithm for PCA image fusion for reducing speckle noise in image.It is proven with the help of some comparison parameters like MSE, SNR, SSIM and PSNR which indicates that output image is reduced version of noise as compared to input image. Hence we can conclude that this proposed algorithm is capable of reducing noise in an ultrasound image and helps the diagnostics a better quality image. It enhances the quality of ultrasound image. It recovers the useful information in ultra sound image overlapped due to speckles. It will provide the radiologist with better view of the Ultrasound image without destroying important features. Also recovers the useful information in US overlapped due to speckles and gives radiologist a better view of image to diagnose the disease.

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