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DENOISING ULTRASOUND SCAN IMAGE FROM SPECKLE NOISE

Sharathbabu.B[1], Ayesha BanuS[2], Naveen Kumar S[3], Deepikaa.S[*4]
School of Information Technology and Engineering, VIT University, Vellore, Tamil Nadu, India.
Email: deepikaa.s@vit.ac.in

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Abstract:

Ultrasound images play a major role in disease diagnosis and in medical treatments. These images are affected by speckle noise which occurs due to interference of the returning wave at the transducer aperture. This paper tries to denoise the ultrasound images by manually applying the speckle noise at various levels and apply the readily available filters to remove the speckle noise. Comparison of the results isanalyzed with various parameters like PSNR, UIQI, SSIM. On analyzing the results wiener filter seems to be effective in reducing the speckle noise.

1. Introduction:

Ultra sound scan images help us to diagnose the internal disorders or track the various internal activities like examining the fetal growth in the pregnant women. An ultrasound scan is aimaging method that uses high-frequency sound waves to take live images from the inside of the human bodies. It's also known as sonography. These ultrasound images are degraded with noise which may lead to a negative impact or false positive diagnosis. This may lead to various confusions.

Consider a patient checking for cysts in the internal layers of uterus. The degraded image may have some cysts like appearance because of the noise which may lead to the conclusion that the patient has the cysts in the uterus and the doctors may go for treating the cysts actually which is absent in the patient. Ultrasound scan images are mainly used in screening internal organs and its working and to aid in treatment of diseases or conditions and also for assessing the progression of a pregnancy.

The most occurred noise in the ultrasound image is speckle noise which occurs due to some unwanted waves. Speckle noise appearance is like sandy dot. This noise makes the images defective.

This may lead to wrong treatment. For resolving this issue, the paper focuses on applying different filters like mean, median, wiener, and laplacian, gaussian. Section 3 explains the proposed work where, the images are taken as input in

(.jpg) format and apply filters for noised image to remove the noise. The results are compared with respect to some image quality parameters like peek signal noise ratio (PSNR),Structural Similarity Index(SSIM), and Universal Image Quality Index(UIQI). Section 4 deals with results of comparison and its discussion. Ultrasound scan images that are manually corrupted with the speckle noise are taken and the noise percentage is increased from 0.1% to 1.0% to demonstrate the comparative measures.

2. Related works:

Denoising is the method of removing the noise from the degraded image. There are different kinds of noise in the images. This paper deals with the speckle noise in particular. The literature survey discusses many issues regarding the denoising techniques.

Sambitet al.[1] has taken general medical images and applied five existing filters. Gaussianand salt& pepper noise has been artificially added. The performance of five filters are compared and analyzed to obtain the best filter. Ayesha et al.[2] proposed a 2 step integration filter to remove the speckle noise and compared the result with pre existing filters. But the images results show that the proposed method is faded than the original image. Alex et al.[3] has proposed selective average filter which smoothes the edges of the digital images affected by the speckle noise and compared with other existing filters. The author used PSNR and SSIM as metrics.SreelekshmySelvin et al. [5] has proposed the l1 trend filter that is applied on color images to reduce salt and pepper, guassian and speckle noise. Jinbum Kang et al. [6] has worked in reducing the speckle noise by a new feature-enhanced speckle reduction (FESR) methodbased on multiscale analysis and feature enhancement filteringis proposed for ultrasound B-mode imaging. The results found to be effective.

3. Proposed work:

The paper focuses on denoising ultra sound image which is degraded by speckle noise. The process is done in the order specified in the figure 1.

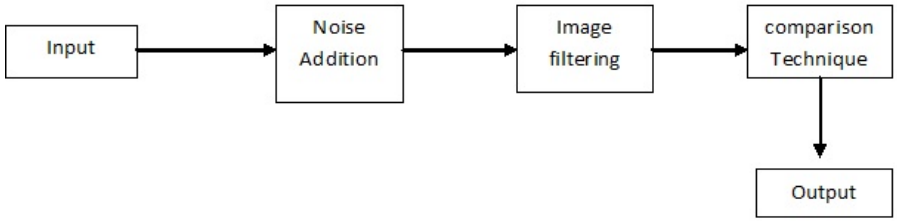

Figure 1- Process flow.

This paper uses the ultrasound scan images in jpg format as input. Ultrasound images plays a vital role in pregnancy analysis. In the ultrasound images speckle noises are added at various levels for every time. Images are filtered using filtering techniques such as mean, median, Gaussian, wiener, laplacian filters.

Mean:

Mean filter is simple and easy to implement method of smoothing images. This filter works with the neighbour window to calculate the mean value of the pixel.

Median:

The median filter is a non-linear filtering technique to reducing the speckle noise. the median filter technique is widely used in image processing under certain conditions.

Gaussian:

The Gaussian filter is used to blur the images and remove the noise from that. Gaussian filter is slightly similar to the mean filter but it uses different kernel. Gaussian filter modify the input signal with the Gaussian function.

Laplacian:

The laplacian filtering technique usesgrey level images as an input and gives another grey level images as output.

Wiener:

The wiener filtering technique is used to reduces the mean square error between the estimated random process and desired process.

Figure 1 (a)Speckle noise image

Figure 1 (b)using mean filter

Figure1 (c)using median filter

Figure 1(d)using Gaussian filter.

Figure 1(e)using wiener filter

Figure 1(F) using laplacian

Comparison parameters:

Peak Signal to Noise Ratio

Peak signal-to-noise ratio, often abbreviated **PSNR**, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.

Structural Similarity Index

The structural similarity (SSIM) index is a method for measuring the similarity between two images. The SSIM index is a full reference metric, in other words, the measuring of image quality based on an initial uncompressed or distortion-free image as reference. SSIM is designed to improve on traditional methods like peak signal-to-noise ratio (PSNR) and mean squared error (MSE), which have proven to be inconsistent with human eye perception.

Universal Image Quality Index

Universal image quality index is easy to calculate and applicable to various image processing applications. Instead of using traditional error summation methods, the proposed index is designed by modeling any image distortion as a combination of three factors: loss of correlation, luminance distortion, and contrast distortion

4. **Results and Discussion:** The results of various filters are tabulated in table 1.

Table 1 – Results of denoising speckle noise.

Noise	Metrics	Mean	Median	Gaussian	Laplacian	wiener
	PSNR	21.1979	21.1945	21.6021	11.2339	24.9817
	SSMI	0.6383	0.6366	0.6616	-0.0944	0.6917
0.1	UIQI	0.5124	0.5078	0.5664	-0.2925	0.5213
	PSNR	18.9418	18.9254	19.1798	9.7873	23.1831
	SSMI	0.5598	0.5593	0.582	-0.1906	0.6633
0.2	UIQI	0.4404	0.4382	0.4912	-0.3737	0.5038

	PSNR	17.5143	17.5121	17.7026	8.7924	21.996
	SSMI	0.516	0.5182	0.5364	-0.2502	0.6444
0.3	UIQI	0.3996	0.4018	0.4477	-0.1495	0.4954
	PSNR	16.5097	16.5295	16.682	8.1108	21.1046
	SSMI	0.4879	0.4874	0.5067	-0.2828	0.6295
0.4	UIQI	0.3773	0.378	0.4195	-0.4416	0.4859
	PSNR	16.5097	15.8323	16.1253	7.6568	20.5063
	SSMI	0.4879	0.4673	0.4919	-0.3025	0.6221
0.5	UIQI	0.3773	0.358	0.4081	-0.4561	0.4853

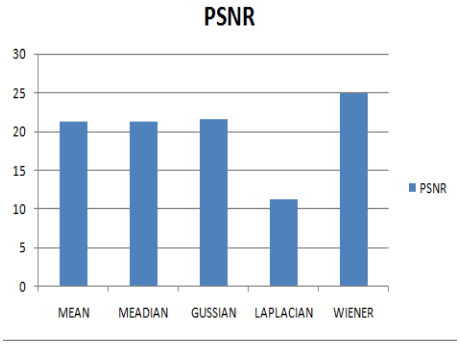

Figure 2 (a) PSNR chart

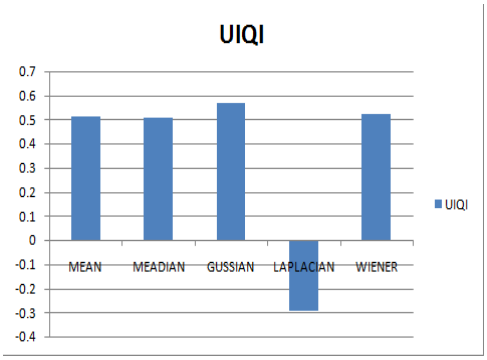

Figure 2(b) UIQI chart

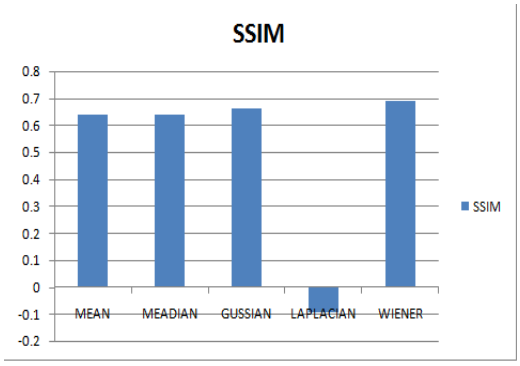

Figure 2(c) SSIM chart.

From the table 1, the PSNR value is high for the wiener filter. PSNR seems to decrease with the increase in the noise percentage in case of all filters. The figure 2(a) shows the results of the PSNR value. Figure 2(b) shows the universal image quality index value plotted in chart. The gaussianfilter has the highest value of all the other filters. Figure 2(C) shows the SSIM values and the wiener filter holds the highest values than the other filters.

Conclusion:

The paper has done a literature survey on speckle noise. The paper used ultrasound scan image as input and artificially added speckle noise at increasing levels from (0.1 TO 0.5%). The pre existing filters like mean, median, gaussian, laplacian and wiener have been applied on noised images and the PSNR, UIQI and SSIM values for the corresponding filters have been calculated and analyzed for removing thespeckle noise. Based on the obtainedresults

in figure 2(a)-2(c) and in figure 1(b)-1(f), wiener filter has the optimum result and higher amount of speckle noise removed. The laplacian filter does not suit for the removal of speckle noise. The second optimum result is obtained from the gaussian filter. Future research would concentrate on speckle noise removal without edge destruction.

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