

## Speckle Noise Reduction from Medical Ultrasound Images-A comparative study

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**Abstract:** In medical image processing image denoising has become a very essential exercise all through the diagnose. Medical images are often deteriorated by noise due to a serious sources of interferences and other phenomenon that affect the measurement process in an imaging and acquisition system. Speckle noise is a random mottling of the image with bright and dark spots, which obscures fine details and degrades the delectability of low contrast lesions. Speckle noise occurrence is often undesirable since it affects the tasks of human interpretation and diagnosis. Speckle noise is a granular noise that inherently exists in and degrades the quality of the images. Generally it is found in Ultrasound image and radar image. Various noise removing methods has been introduced. This paper run a comparative study on various filter efficiencies in removing speckle noise from medical ultrasound images using statistical measures.

**Keywords:** Ultrasound Image,Ultrasonography, Speckle Noise, SNR, PSNR,MSE,RMSE

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### I. Introduction

Ultrasound image is formed from the sum of a large number of reflected waves, which scatters from the target. This scatters are randomly distributed and has random energy. This helps to form speckle noise. So this noise has a statistical nature which can be modeled. This section contains some primary knowledge about speckle noise and two Speckle noise's statistical model.

#### 1. Speckle Noise

Speckle noise is a granular noise that inherently exists in and degrades the quality of the images. Generally it is found in Ultrasound image and radar image.

### II. Study and Modeling

The study and modeling of this noise is important because speckle noise as the most prevalent artifact in Ultrasounds, makes object detection and recognition more difficult. Moreover reduction of speckle directly improves the value of a Sonogram.

#### 2.2 Basic Property

- i. Effects many types of Medical Imaging modalities Caused by constructive/destructive interference of random reflections.
- ii. Random in nature. It Does not correspond to shape of object being imaged.
- iii. It is deterministic. It does correspond to local density and ultrasound reflectivity.
- iv. The Speckle Noise in Ultrasound is Multiplicative, not additive
- v. Additive noise is considered insignificant compared to Speckle

#### 2.1 Consequences in Ultrasonography

Consequences of ultrasonography can be described as follows:

- i. Because Ultrasound Images have very little contrast, edge detection is essential to object detection.
- ii. Ultrasounds depend more heavily on edge detection than other medical imaging modalities.
- iii. Speckle noise can distort or hide edges making object detection less reliable.
- iv. Objects such as tumors or birth defects can go undetected and thus untreated.

### III. Simulation

The formation of speckle and the interference patterns in envelope image are caused by the coherent nature of echo ultrasound imaging systems. It will then reduce the image resolution and object detection

ability. Although the speckle carries information related to the statistics of the scatters, various methods have been

proposed in the past involving frequency and spatial compounding to reduce the speckle. Here we will implement some of the filters, that described in the previous chapter. The software used here is MATLAB. Among the implemented filters some are done by direct coding and some are done by image processing toolbox of MATLAB.

#### IV. Comparison Parameters

The algorithms have been implemented using MATLAB. The performance of various spatial enhancement approaches are analyzed and discussed. The measurement of image enhancement is difficult to measure. There is no common algorithm for the enhancement of the image. The statistical measurement could be used to measure enhancement of the image. The Root Mean Square Error (RMSE), Signal-to-Noise Ratio (SNR), and Peak Signal-to-Noise Ratio (PSNR) are the standard deviation of the image:

Where,  $i=1,2,3,\dots,N$ ,  $b$  is the mean gray level value of the original image and  $b_i$  is the gray level value of the surrounding region and  $N$  is the total number of pixel in the image. The RMSE, SNR, and PSNR are provided below.

**Table : 1**

Statistical Measurement	Formula
MSE	$\frac{\sum(f(I_i)-F(I_i))^2}{MN}$
RMSE	$\sqrt{\frac{\sum(f(I_i)-F(I_i))^2}{MN}}$
SNR	$10 \cdot \log\left(\frac{\sigma^2}{(\sigma(e))^2}\right)$
PSNR	$20 \cdot \log_{10}(255/RMSE)$

Here,  $f(i, j)$  is original image,  $F(i, j)$  is enhanced image,  $\sigma^2$  is variance of original image and  $\sigma(e)^2$  is variance of enhanced image. The original ultrasound image and filtered images of the prostate obtained by various filtering techniques are shown in figure 4.1. If the value of RMSE is low and the values of SNR and PSNR are larger then the enhancement approach is better. The table 2 shows the performance analysis of the proposed approaches and existing approaches with the regard to ultrasound medical images for prostate. It was observed from the figure 4.2 that the proposed M3-Filter removes the speckle noise better than other enhancement approaches.

#### V. Comparison Table

**Table : 2**

FILTER	MSE	RMSE	SNR	PSNR
<b>Min</b>	<b>0.0079</b>	<b>0.1013</b>	25.3248	<b>68.0223</b>
<b>Max</b>	162.808	12.7596	10.6469	26.014
<b>Mean</b>	4.9336	2.2212	<b>40.2901</b>	41.1992
<b>h. mean</b>	10.1359	3.1837	21.3762	38.0722
<b>g. mean</b>	2.5016	2.958	21.2277	38.8358
<b>Midpoint</b>	4.7037	2.1688	39.5441	41.4064
<b>b.midpoint</b>	175.5446	13.2493	5.5354	25.6869
<b>Sd</b>	9.9314	3.1514	14.335	38.1607
<b>Variance</b>	84.1189	9.1716	4.2938	28.8819
<b>Gaussian</b>	131.792	11.4801	4.2767	26.9316
<b>a. median</b>	134.0236	11.5769	4.0548	26.859

### 3. Graphs

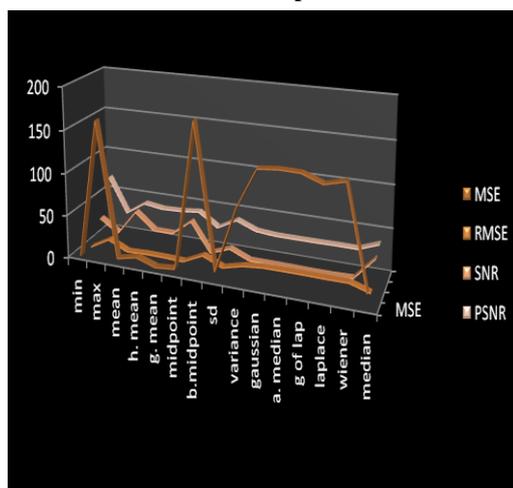


FIGURE: 1 Comparison of various parameters

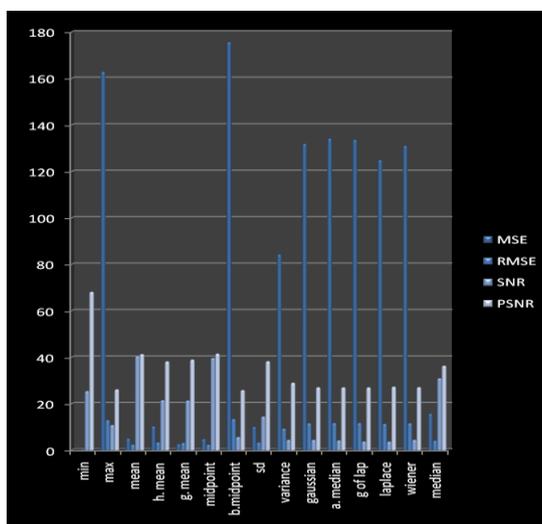


FIGURE: 2 bar comparison of various parameters

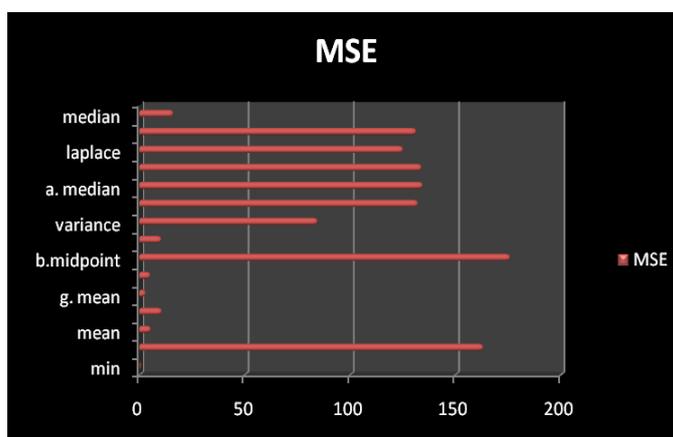


FIGURE : 3 MSE comparison

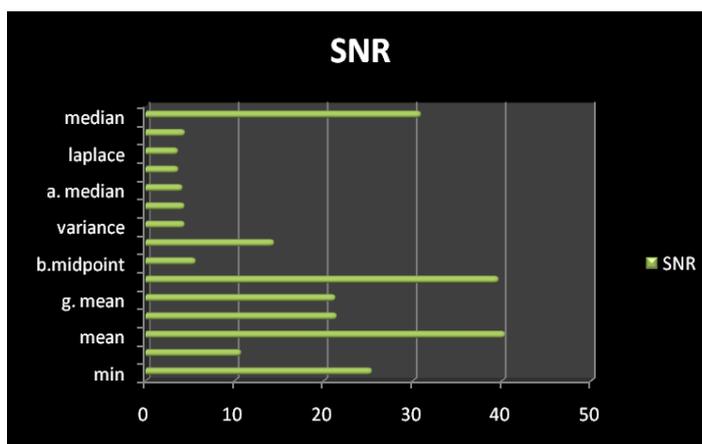


FIGURE: 4 SNR comparison

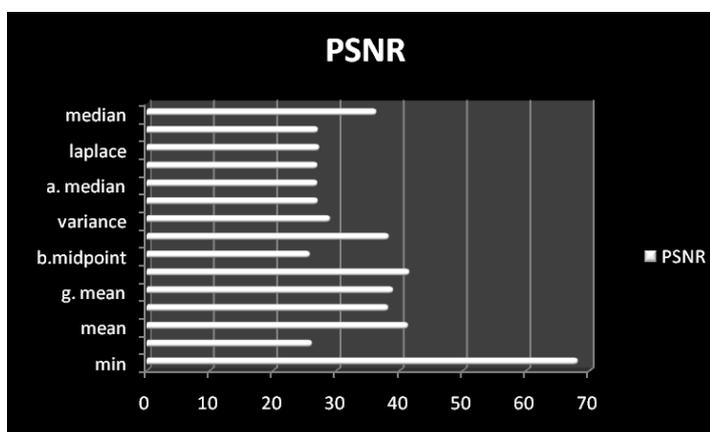


FIGURE : 5 PSNR comparison

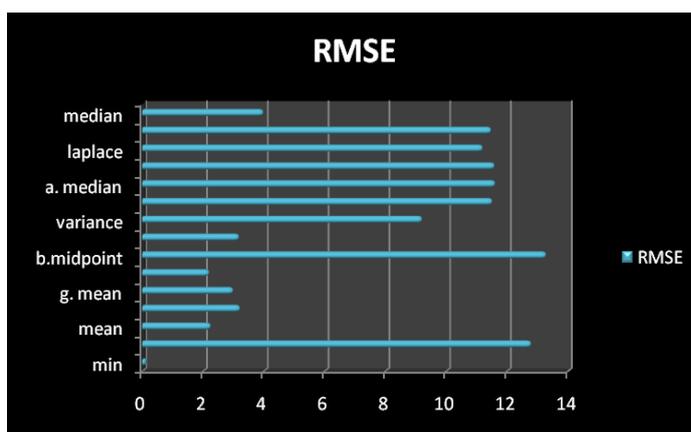


FIGURE : 6 RMSE comparison

### VI. Observation

According to the table -1 the min filter gives minimum MSE ,minimum RMSE . Maximum SNR displayed by Mean filter. Moreover maximum PSNR is obtained from min filter.

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