Speckle and Rician Noise Removal from Medical Images and Ultrasound Images

Saurabh U. Saoji, M. V. Sarode

Abstract: ***In medical images, medical images are corrupted by different types of noise. It is important to get a precise picture and accurately observe the correspondence. Removing noise from medical images has become a very difficult problem in the field of the medical image. The most well-known noise reduction method, which is usually based on the local statistics of medical images, is efficient because of the noise reduction of medical images. In paper, an efficient and simple method for noise reduction from medical images is presented. The paper proposes a filtering system to combine both the Median filter and Gaussian filter to remove the Speckle noise form Medical and Ultrasound images. The image quality is measured through statistical quantities: Peak signal to noise ratio (PSNR). Experimental results show that the proposed system removes Speckle noise from medical images.***

Keywords: Medical Images, median filter, Gaussian filter, Speckle noise.

I. INTRODUCTION

In medical image processing, it is important to obtain accurate images. Poor image quality is a barrier to effective feature extraction, analysis, recognition, and quantification. Therefore, there is a major need to reduce noise from medical images [1]. There are several images modalities currently used for medical image studies. Within the newly developed medical image modalities, Radiographic images and ultrasound images are used for precise measurement of organ anatomy in a minimally invasive manner. Image processing technology plays an important role in medical images to diagnosis and detection of the disease and monitoring the patient from this disease [2]. Radio graphics image, computerized tomography (CT), Ultrasound image and X-ray images, etc, are used in many applications of medical images. This application is very cost-effective for the patient when not deleting the re-image is more cost so that after the image operation is one of the imaging processing techniques to solve this problem for less cost and fast. Medical images are often contaminated with impulsive, additive, or multiplicative noise due to many non-incidents in the imaging process. Noise tends to distort medical imaging by replacing some pixels in the original image with new pixels that have brightness values close to or equal to the minimum or maximum of the allowable dynamic brightness range [3]. Identification of the type of noise in the medical image is carried out in two stages. At the first stage, the criterion for detecting the presence of pulse noise is used. If the result of this criterion is negative, the image is then subjected to the second phase of another criterion to reveal the additive or multiplicative nature of the noise [1] [4].

The Radiographic images and the ultrasound image are tested to eliminate noise. Radiographic images are a powerful diagnostic technique. However, the noise incorporated during image acquisition degrades human interpretation or computer-aided analysis of images. The noise in Radiographic image is due to a Rician distribution. Gaussian noise, the noise of the Ricians depends on the signal and therefore separating the signal from the noise is a difficult task. Ultrasound is widely used in medicine [5]. It is used for soft tissue imaging in organs such as liver, kidney, spleen, uterus, heart, brain, etc. A common problem with ultrasound imaging is that because of these types of noise caused by the imaging techniques used, which can be based on coherent waves such as laser acoustic imaging, the display must be done to improve image quality for more accurate diagnosis. The main purpose of image display technology is to remove these noises while maintaining as much as possible the important characteristics of the signal. There is a lot of work to restore images corrupted by noise. Create a more accurate version (in pixels) of the decision by the image to eliminate the noise of using multiple filters. Taking into consideration the surrounding pixels, extreme “noisy” pixels can be eliminated.

Median filter [2] [6]: The median filter is also the simplest technique and it removes the noise from an image. The median filter is made by taking the size of all the vectors inside a mask and sorting the quantities. The pixel with the median magnitude is then used to replace the studied pixel. The Median filter expressed as:

$$f(x,y) = median_{s,t \in Sxy}\{g(s,t)\} \quad (1)$$

Where, Sxy coordinates in a rectangular sub-image window are represented. (x,y) is the center point. And the median shows the median values of the window.

Gaussian Filter [7]: widely used in the effects of graphic software, usually to reduce image noise. Because the Gauss Fourier Transform is a different Gaussian type, applying Gaussian Blur reduces the high-frequency component of the image. Use a Gaussian filter to remove blurring image noise. The Gaussian function is:

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{x^2}{2\sigma^2}} \quad (2)$$

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***** Correspondence Author

Saurabh U. Saoji*, Department of Computer Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, India E-mail: susaoji@bvucoep.edu.in

Dr. M. V. Sarode, Department of Computer Science, Government Engineering College, Yavatmal, India, E-mail: mvsarode2013@gmail.com

The paper, propose a system to remove the Speckle noise form Medical and Ultrasound images. In paper the study about the related work is done, in section III the proposed approach is presented, in section IV the results and discussion are done, and in a final provided a conclusion in section V.

II. LITERATURE REVIEW

The paper presents an efficient and simple method for reducing noise from medical imaging. In the proposed method, the median filter is modified by adding more characteristics [1]. A new method for noise filtering in images according to the Rician model is proposed in this paper. To do so, they derive a (new) closed-form solution of the linear least-mean-squared error (LMMSE) estimator for this distribution. Besides, a series of methods have been developed to automatically estimate noise power. These methods use the sample distribution information in the local statistics of the image, such as local variance, local average, and local mean square values. Therefore, dynamic estimation of noise leads to recursive versions of LMMSE that show good performance both in noise cleaning and in function storage. It also includes the derivation of the probability density functions of some local sample statistics for Rayleigh and Rician model [2].

An algorithm for the removal of Poisson noise in X-ray images and the removal of the Rician noise in magnetic resonance images has been developed. The noise of these modalities does not follow the Gaussian distribution. An algorithm using the discrete wavelet transform, the non-destructive wavelet transforms, the DoubleTree complex wavelet transform, the double density discrete Wavelet Transform, and the double density dual Tree complex Wavelet Transform is developed [3]. In paper [4], 200 MR images of the brain (3T MRI scan), heart and Breast have been selected for the test of noise reduction technology with the above conversion. The results show that the NSCT gives good PSNR values for random and impulse noise. DD-DTCWT has the function of good noise suppression for speckle and Rician noise. NSCT and DD-DTCWT correspond well to images affected by Poisson noise. The highest PSNR values obtained against salt and pepper and additive white gas noise are respectively 21.29 and 56.45. For speckle noise, DD-DTCWT is 33. Give 46, it is better than NSCT and curvature. Value 33.50 and 33.56 is the highest level of PSNRs in NSCT and DD-DTCWT for Poisson noise. Paper presents the importance of the reduction of Speckle and the segmentation option of the lesion in the Optical Coherence Tomography (OCT) image is emphasized. Qualitative and quantitative results are reported. Then apply image segmentation to the image of multiple teeth. This paper outlines the evaluation of dental caries and the possibility of the regression analysis on the high-strength response region by the appropriate threshold processing. Our results show that the Rotational kernel transform (RKT) filter of a 9×9 kernel size is required for noise reduction and subsequent feature segmentation analysis [5]. The new model is called RiIg distribution. The theoretical basis of this model is briefly presented and an algorithm to estimate its parameters from the data is given [6]. The article proposes filtering techniques for the elimination of noise from digital image stains [7].

For the medical image noise removal, bilateral filtering was carried out. Therefore, to obtain optimal results, it is necessary to estimate the parameters [8]. In paper, a nonlinear filtering method for Rician noise removal is proposed. It also provides edge-keeping and structure-MRI [9]. Two new models for eliminating the multiplicative noise based on the sum are proposed based on a generalized variation (TGV) penalty. The regularization of TGV proved to be able to remove the staircase artifact by mathematically noticing the higher-order smoothness. In particular, the method is superior to the TV-based algorithm in the case of high image smoothness [10]. It is important to get a precise picture and accurately observe the correspondence. Removal of noise from medical images is currently a very difficult problem in the field of medical imaging; in this paper, they will use three kinds of filters as an average filter [11]. The author proposes and does a two-step noise removal procedure, in which the bias is removed from the image of the size of the Square and it denies itself the square root of this image in the wavelet region. This noise removal step takes into account the noise correlation, but the distinction is insignificant from the wavelet coefficients. The estimated statistics of wavelet coefficients of these two classes are used in the Bayesian estimator [12].

The author in this paper has recently proposed a speckle-reduced anisotropic diffusion filter to facilitate the automatic processing of images. The characteristics of the numerical scheme associated with this filter are analyzed using a semi-explicit scheme. This filter is then extended to the anisotropic diffusion of the matrix, allowing different levels of filtering in the image's contour and the principal curvature direction [13]. In the image processing, it is expected that the performance of qualitative inspection and quantitative image analysis technology of the image is improved by the restoration. In this paper, we propose an adaptation of a non-local (NL) mean filter for speckles, ultrasound (US) image reduction [14].

III. SYSTEM OVERVIEW

A. Proposed System Overview

Figure 1 shows that, proposed system architecture. The proposed filtering system removes Speckle noise from a medical image. The proposed method is one of the order statistics filters that give more accurate output than other existing order statistics filters. The system takes input image as a Radiographic image of the human teeth.

The original image is filtered by using an existing Median filter and Gaussian filter, proposed Advanced Median filter, and Advanced Gaussian filter used to calculates the Peak signal to noise ratio (PSNR).

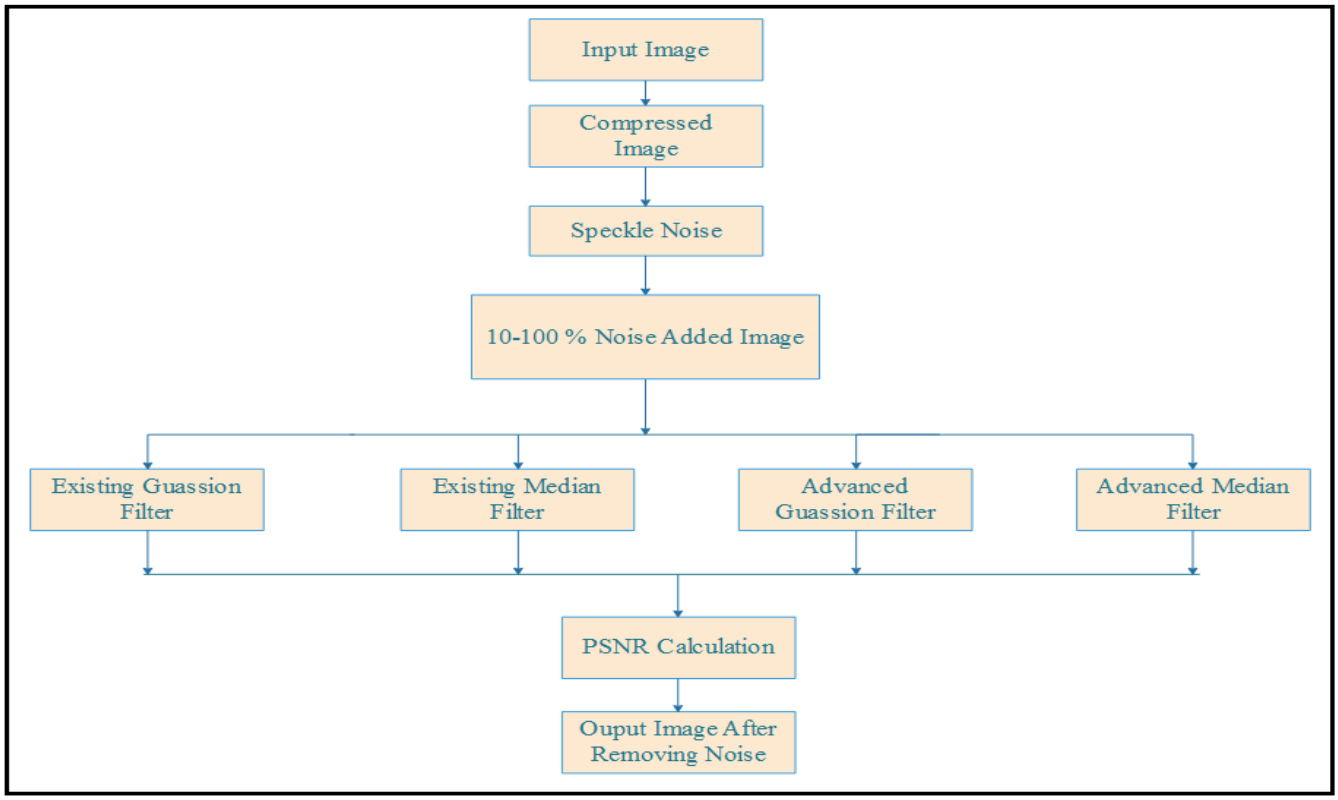

Fig 1: System Architecture

The system shows that the proposed advanced filtering system is remove Speckle noise and Rician noise. The peak signal to noise ratio (PSNR) value shows the quality of the image.

IV. RESULT AND DISCUSSION

The proposed system is very promising as an algorithm for eliminating noise from Radiographic images and ultrasound images. To test the proposed system, we took Radiographic images of the human teeth. Figure 2 shows the original noisy Radiographic images.

Fig 2: Original Noisy Radiographic images of human Teeth

Since the noise present in the image is also concerned, the initial pre-processing is done using the proposed system; the original image will pass through the proposed filtering system. The result of the experiment using the proposed noise removal system is shown in figure 3. When the proposed noise removal system is applied to the Radiographic images, the background part is excluded. Figure 3 shows that Speckle Noise is significantly removed.

Fig 3: Radiographic images of human Teeth after removing Speckle noise

To show the accuracy of an image after applying the proposed filtering system, there are two-way. First, observe the image to lookout. This is subjective. The execution of this process does not produce good results; it varies from user to user. The second process is based on mathematical or probabilistic models. The image quality is measured by using statistical quantities: Peak signal to noise ratio (PSNR).

$$PSNR = 20 \log_{10}\left(\frac{Max\ pixel\ value}{\sqrt{Mean\ Square\ Error}}\right) \quad (3)$$

The figure 4 shows Peak signal to noise ratio (PSNR) graph. Table I shows the comparison between the Existing Median filter, Gaussian filter, and proposed Advanced Median filter and Advanced Gaussian filter.

The graph shows that the proposed Advanced Median and Advanced Gaussian filter removes the more noise as compared to existing Median and Gaussian filter.

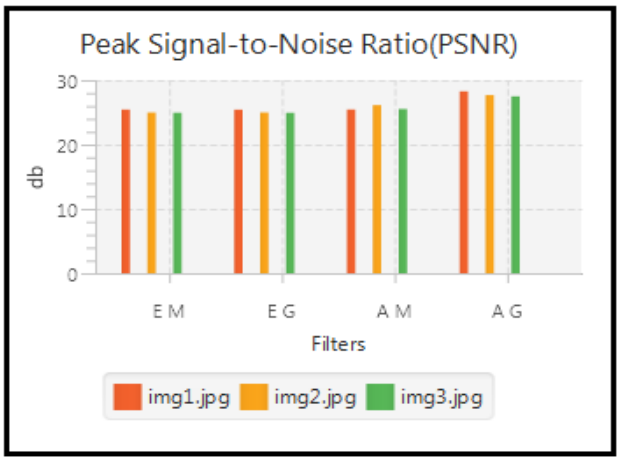

Fig 4: Peak Signal-to Noise Ratio (PSNR) graph

Table- I: PSNR Results of Filtering Methods

Filters	*Img1*	*Img2*	*Img3*
EM (Existing Median filter)	25.4089	25.0022	24.9246
EG (Existing Gaussian filter)	25.4216	25.0024	24.9411
AM (Advanced Median filter)	25.4326	26.147	25.5126
AG (Advanced Gaussian filter)	28.2624	27.6424	27.5045

The Table I show that the advanced proposed filtering system got the highest PSNR value.

V. CONCLUSION

The efficient and simple method for noise reduction from medical images is presented. The system removes the Speckle noise and Rician noise. The results show that the proposed filtering system superior to other filtering methods. The system is compared with the Existing median and Gaussian filter using statistical quantities like PSNR. Finally, the system shows that the system removes Speckle noise and Rician noise. The proposed system is performing better than other filtering methods.

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AUTHORS PROFILE

S. U. Saoji Completed M.Tech in Mobile Technology and B.E in Information technology and published more than 12 papers in international and national journals.

Dr. M. V. Sarode completed Ph.D in Image Processing from Sant Gadge Baba Amravati University Amravati and work as Superviser for many students in Amravati University and M.E from Swami Ramanand Teerth Marathwada University, Nanded and B.E from YCCE Nagpur.