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Noise Removal in Medical Images using Shearlet Transform

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ABSTRACT

Image denoising is the removal of noise from original images. In this paper, Image denoising method is implemented on CTA medical image for better understanding. Shearlet transform method is used to eliminate noise from Medical CTA image. Existing methods are Median filtering, Wiener filter and Wavelet Transform method. Output Image of Median filtering, wiener filter and Wavelet transform is a blurred one in which physician does not find accurate diagnosis or treatment. In order to overcome those drawbacks the Shearlet transform is proposed. The output results give more insights about the images and denoise the overall scope of finding more perceptions.

Keywords: Medical Image, Image denoising, Median Filter, Computer Tomography, Angiography, Wavelet Transform, Shearlet Transform.

INTRODUCTION

Medical imaging is the visualization of body parts, tissues, or organs, for use in clinical diagnosis, treatment and disease monitoring. Whereas, Medical image processing deals with the development of problem-specific approaches to the enhancement of raw medical image data for the purpose of selective visualization as well as further analysis. Medical Image Processing consists of image preprocessing, image registration, feature extraction, image classification and retrieval. A major problem for handling the medical images is the presence of various granular structures such as speckles noise. Medical images are corrupted by noises during the transmission and reception process. Hence noise reduction has been a conventional issue in medical image processing. The main aim of this work is to denoise the high noise density image efficiently, with minimal computation cost. Speckle is the random granular texture that obscures anatomy in ultrasound images usually called noise. Medical images acquired in most radiological applications are visually examined by a physician. The purpose of image denoising methods is to process an acquired image for better contrast and visibility of features of interest for visual examination as well as subsequent computer-aided analysis and diagnosis. Medical images are regularly affected by noises due to machine specifications, detector specifications and surroundings. The fundamental objective of image denoising is to suppress noise from images while protecting their features, namely meaningful edges or texture details Medical images show characteristic information about the physiological properties of the structures and tissues. However, the quality and visibility of information depends on the imaging modality and

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the response functions (such as the point spread function [PSF]) of the imaging scanner.

Medical images from specific modalities need to be processed using a method that is suitable to enhance the features of interest.For example, a chest X-ray radiographic image shows the anatomical structure of the chest based on the total attenuation coefficients. If the radiograph is being examined for a possible fracture in the ribs, the image enhancement method is required to improve the visibility of hard bony structures. But if an X-ray mammogram is obtained for examination of potential breast cancer, an image processing method is required to enhance visibility of micro calcifications, speculated masses, and soft-tissue structures such as parenchyma. A single image enhancement method may not serve both of these applications. Image denoising intends to recover the unknown original image from a noisy estimation or polluted perception and upgrade the contrast. Thus, image enhancement and image denoising tasks and methods are very much application-dependent.

The paper is organized as: section II provides the literature survey of Image denoising of Medical Images and methodologies. Proposed method of Image denoising is presented in section III. Section IV concludes the entire work in the implemented concept.

LITERATURE SURVEY

This section highlights the literature survey of various approaches used by different researchers in the field of image denoising Hilal Naimi et.al [1] dealt with Medical image denoising using dual tree complex thresholding wavelet transform and Wiener filter. In this paper Image denoising is mentioned which is the process to remove the noise from the image naturally corrupted by the noise. The wavelet method is one among various methods for recovering infinite dimensional objects like curves, densities, images, etc. The wavelet techniques are very effective to remove the noise because of their ability to capture the energy of a signal in few energy transform values. The wavelet methods are based on shrinking the wavelet coefficients in the wavelet domain. We propose in this paper, a denoising approach basing on dual tree complex wavelet and shrinkage with the Wiener filter technique (where either hard or soft thresholding operators of dual tree complex wavelet transform for the denoising of medical images are used). The results proved that the denoised images using DTCWT (Dual Tree Complex Wavelet Transform) with Wiener filter have a better balance between smoothness and accuracy than the DWT and are less redundant than SWT (StationaryWavelet Transform).

P.V.V.Kishore and K.L.Mallika [2] dealt with the techniques start by the Denoising Ultrasound Medical Images with Selective Fusion in Wavelet Domain. This paper submits a twofold technique to remove this multiplicative speckle noise and to bring a contrast between the object of the interest and the remaining image. First fold includes block based hard (BHT) and soft thresholding (BST) on pixels in wavelet domain where in which the original ultrasound image is divided into Non Overlapping blocks of sizes 8, 16, 32 and 64. The second fold includes restoration of the object boundaries and texture with adaptive wavelet fusion which are lost by the blurring effect caused as a result of the first fold. Fusion of wavelet coefficients of original US image and block thresholded US images assuaged to restore the degraded object. Fusion rule and wavelet decomposition level are made adaptive for each block using gradient histograms with normalized differential mean (NDF) to introduce highest level of contrast between the denoised pixels and the object pixels in the resultant image.

Xu Mingliang and Lv Pei[3] described Medical image denoising by parallel non-local means. In this study, The generation process of medical image will inevitably introduce certain noises. These noises will degrade the image quality and affect the final clinical diagnosis. Therefore, denoising plays an important role in the preprocessing of medical image before the formal diagnosis and treatment. In this paper, the classical NLM algorithm is improved to denoise medical images by involving a novel noise weighting function and parallelizing.

Chaitali Kadam et.al [4] described a Comparative Study of Image Denoising Techniques for Medical Images. In this Paper medical images plays the most important role. It is used in the diagnosis of the diseases like cancer, diabetic retinopathy, fractures in bones, skin diseases etc. The processes of the medical imaging are different for different type of diseases. The capturing process introduced the noise in the medical image. To proper diagnosis of the diseases, the captured images need to be noise free. In this paper, different noise and denoising algorithm has been explained. The linear spatial filter smoothing the image when using the fixed window but this method blurred the image and smoothen the sharper image so important information may lose. To remove the disadvantage of the mean filter, the median filter is developed which remove the uniform noise while preserving the edges. The transform domains filter mostly to improve the PSNR value.

Mamta et.al[5] described Novel Method for Denoising Medical Image Using 2nd Level Discrete Wavelet Transform and Bilinear Filter. In this research paper, image is first decomposed using filter into eight sub bands using 3D DWT and bilateral filter technique and in this process we got approximation coefficient using DWT and once again DWT technique used on approximation coefficient image then we applied bilateral filter and the detail coefficients are subjected to Wavelet Thresholding. After that there is requirement of image reconstructed and this process is executed by inverse wavelet transform (IDWT) of the resultant coefficients and then it is filtered using bilateral filter. In our research work two types of images are considered which are MRI images and Ultrasound images. In this work IDWT process carried out two times that is why this research work is known as 2 level DWT process. In this process finally two parameters are calculated PSNR and MSE.In order to overcome the drawback that is full of noise of existing method wavelet transform, shearlet transform is proposed.

PROPOSED METHOD

Shearlet transform

Shearlet transform is an extension of wavelet transform in which it has anisotropic features such as edges and curves. shearlet systems are particularly well adapted to represent anisotropic features (such as curves) that are often crucial in multidimensional data. The resulting representation has proven well-suited for image processing tasks such as inpainting, denoising or image separation. Similar to wavelet systems, shearlet systems are constructed by modifying generator functions.

For wavelet systems, these functions are isotropically scaled and translated. While this is enough to provide an optimally sparse representation for an interesting class of 1D function it fails to do so in higher dimensions.

To compensate this shortcoming, the direction of the generator functions has to be varied. In shearlet theory, this is accomplished by shearing and anisotropic scaling.

The shearlet transform is unlike the traditional wavelet transform which does not posses the ability to detect directionality, since it is merely associated with two parameters, the scaling parameter a and the translation parameter t. The idea now is to define a transform, which overcomes this vice, while retaining most aspects of the mathematical framework of wavelets e.g., the fact that

- The associated system forms an affine system,
- The transform can be regarded as matrix coefficients of a unitary representation of a special group,
- There is an mra-structure associated with the systems.

The basic idea for the definition of continuous shearlets is the usage of a 2-parameter dilation group, which consists of products of parabolic scaling matrices and shear matrices. Hence the continuous shearlets depend on three parameters, the scaling parameter a > 0, the shear parameter s ∈ R and the translation parameter t ∈ R2, and they are defined by

$$\psi_{a,s,t}(x) = a^{-3/4}\psi\left(D_{a,s^{-1}}(x-t)\right)$$

where

$$D_{a,s} = [a, -a^{1/2}s; 0, a^{1/2}]$$

The mother shearlet function ψ is defined almost like a tensor product by

$$\psi(\xi_1, \xi_2) = \psi_1(\xi_1)\psi_2(\xi_2/\xi_1)$$

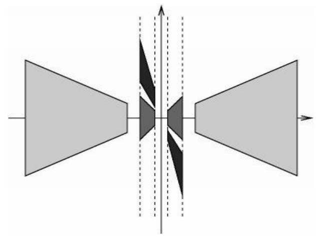

Figure-1

where ψ1 is a wavelet and ψ2 is a bump function. The Figure-1 illustrates the behavior of the continuous shearlets in frequency domain assuming that ψ1 and ψ2 are chosen to be compactly supported in frequency domain.

The associated continuous shearlet transform again depends on the scaling parameter a, the shear parameter s and the translation parameter t, and is defined by

$SH_f(a,s,t)=<f,\psi_{a,s,t}>$

This transform can also be regarded as matrix coefficients of the unitary representation

$(\sigma(a,s,t)\psi)(x) = \psi_{a,s,t}(x)=a^{-3/4}\ \psi\ ((D_{a,s}^{-1}\ (x-t))$

of the shearlet group $S=R^{+} \times R \times R^{2}$ with multiplication given by

$(a,s,t) \bullet (a',s',t') = (a\,a',\ s+s'a^{1/2},\ t + D_{a,s}\,t')$.

With the help of the Shearlet transform technique, the image Denoising is carried out. The following Figure-2a shows the original image and the 2-b shows the noisy image and 2-c shows the final Denoised image with psnr value as 32.5095 db.

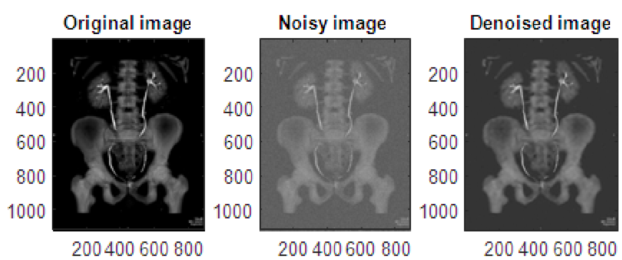

Figure-2: a.Original Image0, b. Noisy Image,sigma=30 c. Denoised Image psnr=32.5095 db

The following Figure-3a shows the original image and the 3-b shows the noisy image and 3-c shows the final Denoised image with psnr value as 32.5095db.

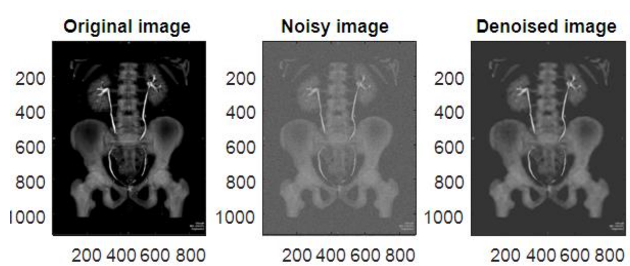

Figure-3: a.Original Image, b. Noisy Image, sigma=30
c. Denoised Image psnr=28.2525db

The following Figure-4a shows the original image, 4-b shows the noisy image of salt and pepper, 4-c shows the final Denoised image with psnr value as 53.792 db and 4-d shows the Gaussian filtering and PM output image.

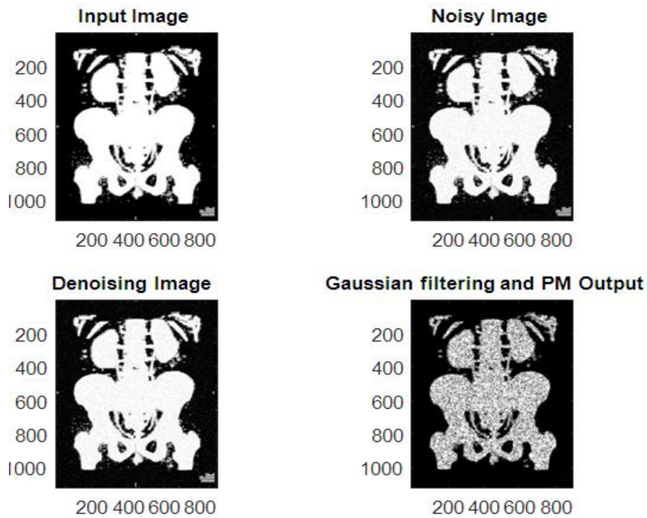

Figure 4: a.Input Image, b. Salt & Pepper Noisy Image, c. Denoising Image, d.Gaussian filtering and PM output and Denoised Image psnr=53.792 db

Now the proposed technique, Shearlet transform is applied for Denoising of the image. Figure 5a shows the original Image,5b shows the Noisy Image,5c shows the denoised Image with psnr=14.3858db.

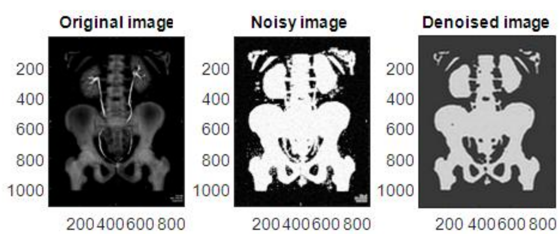

Figure 5: a.Original Image, b. Speckle Noisy Image, sigma=5 , c. Denoised Image psnr=14.3858 db

The following Figure 6a shows an Input image,6b shows the Noisy Image,6c shows the Denoising Image,6d shows Gaussian filtering and PM output.

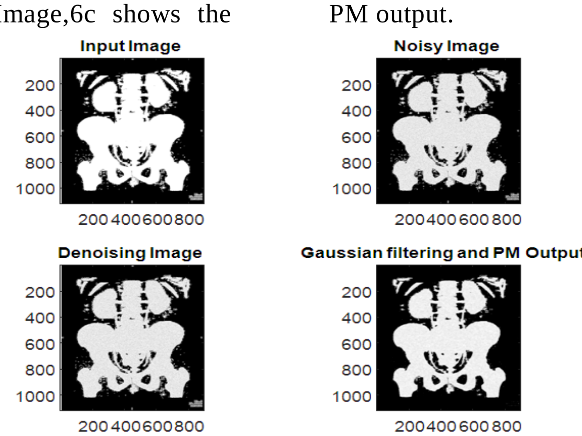

Figure 6: a. Input Image, b. Speckle Noisy Image, c. Denoising Image, d. Gaussian filtering and PM output and Denoised Image psnr=57.32 db

Table-1: Comparison of Input and Output Image using Shearlet Transform Method With Wavelet transform GF and PM

Method	Noise	Image	Sigma Value	Psnr(db)
Shearlet Transform	**Random**	**Output Image**	30	32.5095
			60	28.2525
	Salt& Pepper	**Output Image**	5	14.3858
	Speckle	**Output Image**	5	14.3058
Wavelet Transform	**Random**	**Output Image**	0.5	47.1443
	Salt &Pepper	**Output Image**	0.039	53.792
	Speckle	**Output Image**	0.8	59.097

The above Table-1 shows the superiority of shearlet transform method in comparison with the conventional wavelet transform. From the Table-1 Shearlet transform is very well suited for eliminating unwanted noises from CTA image. Psnr value of shearlet transform is very low when compared with wavelet transform.

CONCLUSION

The Shearlet transform method gives very good image restoration than the Existing method Wavelet transform. Wavelet transform gives the output image with very much noise. But Shearlet transform gives very good result with full elimination of noises with respect to types of noises. Smoothing is done with the help of The The shearlet transform. It is clear from the above discussion that applying Shearlet transform method can help figure out restored details from medical images which can be very useful for the experts. Physicians can diagnose minute blood vessels and bony fractures easily from the output Image.

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