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A Review on Image Denoising Based Techniques

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Abstract

In medical field the ultrasound images are commonly used. There are many issue in the medical images due to introduction of noise. The speckle noise effects the quality of the image. It degrades the image in several ways. It makes many information invisible which is required for the diagnosis purpose. There are many methods to make the required information visible In this paper the study of different methods are adapted which compensate the speckle noise.

Keywords:
Medical images; discrete wavelet transform; Speckle noise; speckle filter

1. Introduction

Ultrasound images or medical images are real time images in x-ray images different kind of injuries can be seen. If the Speckle noise present in the x-ray image then the fracture will not be clear. It degrades the quality of image in the image Parameters contrast, resolution and other important information. Reduction in speckle noise however do not solve all the issues. Because the problem of blurring takes place[1].So the physicians uses the effected images than the one which is filtered through different techniques. The ultrasound or medical images are also known for their non radioactivity. These images are also inexpensive. This is done because the required important information is invisible in that way. So the original image directly taken from x-ray source is oftently used. the nature of image may be additive or multiplicative. In case of speckle noise it is multiplicative in nature. This noise is due to the back scattering of the incident wave which undergoes change in their phases in a random way and this change in phase may be constructive or destructive in nature. This noise particularly delays the interpretation of the image.Mathematically the speckle noise can be written in the following way:

$$g(x,y)=f(x,y)*n(x,y)$$

In the equation the n(x,y) represents multiplicative nature.

Speckle noise can be modeled as:

$$v=fV$$

f={f1,f2....fN} is noise free image.

V=(v1,v2...vN) is unit mean random field.v=(v1,v2....vN) is speckle noise.In next section of the paper denoising methods are explained.In third section the wavelet based methods are explained and in last section the discussi-on various denoising algorithms will be done : wiener filter ,lee filter, kuan Filter,median filter ,frost filters are studied.

2. Standard despeckling methods:-

Many filters are available in which some have better interpretations while others have good noise reduction quality. The best speckle noise reduction filters are lee filter,median filter,frost filter and kaun filters.

Some filters uses kerne window which is a square moving window and this is based upon spatial filtering techniques.this works on mainly in two places.one in center and other place is sorrounding pixel
The size of window may vary from 3 by 3 to 33 by 33,but the only condition is that the size of window must not be even.it should be odd.if size of window is more then over smoothing causes loss of information and if size is very small then also it will not give expected results.The most used window sizes are 3 by 3 or 7 by 7 which gives good results[3]

2.1 Median filter

It works on center pixel means.In this the pixel by pixel moving is done,and then each value is replaced by the median value of the pixel neighboring.The neighbors pattern are called windows in which sliding is done pixel by pixel over the entire image.While calculating median the the pixels are sorted out into numerical order from windows and then replacing the pixel with middle pixel value.This filter technique is non linear filtering technique.Salt and pepper noise is removed by this method. The effectiveness of this filter lies mainly in strong spike components.The characteristics needs to be preserved in this.The disadvantages of this filter is its high time consumption.For sorting different sets intensity value more time is
Required.[9]

2.2 Wiener filter

Wiener filter or least mean square filter are same.In 1942 this filter is proposed.It is applied adaptively on the image according to the variance values.it performs the inverse filtering and noise smoothing results in minimizing the overall mean square error.This is the linear way of estimation of original image[10].The performance of this is accordance to the variance,if its small then it performs smoothly otherwise in case of high variance it performs less smoothy.This way of approaching give good results than linear filters.Wiener filters are expressed by:

$$f(u,v)=\frac{H(u,v)^*}{H(u,v)^2+\left[Sn(u,v)/Sf(u,v)\right]}G(u,v)$$

Suppose this equation is no. 1

$H(u,v)^2$ is function of degradation and $H(u,v)^*$ is the complex conjugate function.G(u,v) is the degradation in image.Functions $S_1(u,v)$ represents power specctra of original image and $S_n(u,v)$ is power spectra of noise image[3]

2.3 Kuan filter

Kuan filter is multiplicative as well as local linear filter.It based upon multiplicative order and represents minimum square error filter.it does not behave like lee filter that means it does not make approximation based upon noise variance in filter window.It is a model in multiplicative nature but additive linear in form.the weighted function in this is represented by :

$W=(1-C_u/C_i)/(1+C_u)$

C_u is calculated by:

$C_{u}= \sqrt{1/ENL}$
$C_i=S/Im$

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C_i is variation coefficient ,S is standard deviation in window filter and I_m is mean intensity value in window.

The disadvantage of this filter is that a special parameter is needed called as ENL parameter for calculations[4]

2.4 frost filter

Frost filter convert the pixel of interest in weighted sum of values with moving kernals of n by n.This factor decreases with the distance from pixel value of interest.This weighted factor increment value for center pixels with in kernal as variance increases.This filter is spatial filter can be called as adaptive filter in spatial domain.it is based upon multiplicative order of noise.it has following expression:

$DN=\sum_{n\times n}K\alpha e^{-\alpha}|t|$ where K=constant of normalization
I represents local mean value while $|t|$ is equal to $|X-X_0|+|Y-Y_0|$ and n is moving kernal size in next equation which is as follows:

$\alpha=(4/n\sigma^2)(\sigma^2/I^2)$ [5]

2.5 Lee Filter

The main function of using this filter is reduction in speckle noise. The assumption used is that variance and mean of pixel of interest is same or equals to variance and local mean of all pixels with in moving the kernal. It mainly based upon the variance. If the variance areis less or constant then smoothing action will not be performed. If not so then smoothing action can be performed.

Img(i,j) =im+(Cp-Im)....(2)

in which pixel value at indices that is i and j after filtering operation.im represents mean intensity value of filter window.

$W=\sigma^2/\sigma^2+p^2$......(3)

σ^2 represents variance of the pixel with in the value of filter window and can be calculated as:

$\sigma^2=[1/N\sum_{j=0}^{N-1}(x_j)^2]$.....(4)

N is size of filter window and X_j represents the pixel value at indices j within filter window.

$P^2=[1/M\sum_i=0^{M-1}(Y)^2$........(5)

The parameter P tells about the additive noise variance which is very important in image and Y_j shows value of each and every pixel in the image.

3. Wavelet Filters

3.1 Wavelet Denoising Methods:

There are many techniques which can be used to reduce mainly speckle noise with the use of wavelets particularly.

Wavelet noise filtering:

Here the wavelet based thresholding is used which is particularly known as discrete wavelet transform .In DWT the first step is to divide the image into four parts HH,HL,LH and LL and the other part which is known as the approximation part is divided mainly into two parts or subbands, Here the approximation part is represented by LL. And the rest part or other part is known as detailed part in which three parts that is HH,LH and HL is defined. The operation will be performed on the detailed part due to the occurence of noise the high frequency part mainly which is detailed part.

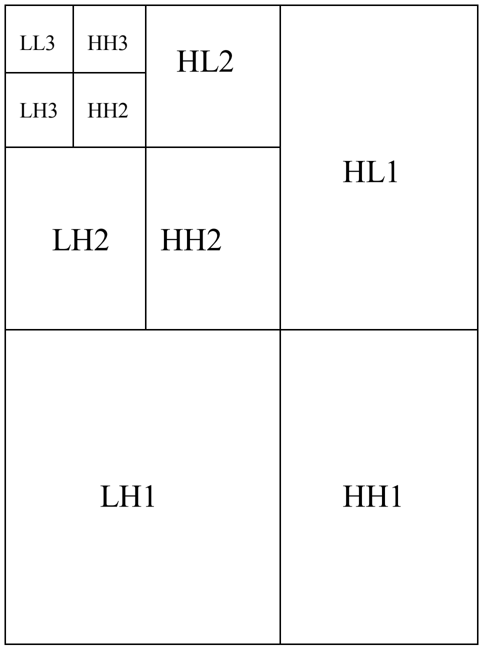

Fig: Level two thresholding of image[8]

DWT basically used to decrease the speckle noise from image.The main three steps are given as follows:

1. Initially calculate the DWT of image.
2.Threshold wave coefficients.
3.Calculate the IDWT to get noise free image.

Soft and hard thresholding are of major concern here.The soft thresholding basically used for deleting high frequency components in which the speckle effect takes place.But the main disadvantage here is that it also loses its information data.The function for soft thresholding is as follows:

$n_2(w)=(w-sgn(w)T)I(w|w|>T)$

Where sgn(x) represents sign function of x.The hard thresholding is less preferred over soft thresholding.

Hard thresholding effects or deletes the low frequency component so results in lose of information again in this case,The function for hard thresholding is given as follows:

$n_1(w)=(wI)(|w|>T)$

W represents wavelet coefficient,T represents threshold[2][6][7].

In that way these there sholding are done to decrease the speckle effect. However these techniques also causes some unwanted results which is not required.So study of these algorithm are very important.

4. Discussion:

Study on various types of filters have been done and also on wavelet based techniques .The performance of wavelet outperforms better results as comparison to the other techniques. The reason behind using this algorithm is that other filters have much disadvantages than this technique. So these filters are not used here because these are unable to reduce speckle noise properly from the medical image. In wavelets technique the most widely used algorithm is discrete wavelet transform which can be written as DWT for reduction of speckle noise. Standard filters have some constraints of resolution degradation but they still perform well. These filters are based upon fixed window that is this window is placed on specific part and then this is moved on the next part and works on it. Some filters creates over smoothing so results in loss of needed information. Wavelets has three main properties that is multire solution, sparsely and multiscale nature.

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