ISSN:0975-9646

P.Deepa et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (3) , 2014, 4205-4209

Performance Evaluation of Various Denoising Filters for Medical Image

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Abstract- Visual information transmitted in the form of digital image is becoming a major method for communication in modern age but the image obtained after transmission is often corrupted with noise. Removing noise from the original signal is still a challenging problem for researchers. There have been several published algorithms and each approach has it assumption, advantages and limitation. This paper presents a review of some significant work in the area of image denoising filtering techniques applied to medical image. The performance of these techniques investigated the problem of image degradation which might occur during the acquisition of the images, optical effects such as out of focus blurring, camera motion, flat-bed scanner and video images. We touch the images of Computed Tomography (CT) with a set of predefined noise levels. The performance of these techniques was evaluated with respect to two quantitative measures, Peak Signal-to-Noise Ratio (PSNR), and Mean Square Error(MSE).

1. INTRODUCTION

Today medical imaging technology provides the clinician with a number of complementary fast, flexible, and precise diagnostic tools such as X-ray, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) images. MRI, CT scan and X-ray are the most methodologies widely used to visualize human anatomy. Medical images often need preprocessing before being subjected to statistical analysis. A common preprocessing step is filtering. We study spatial domain and transformed domain filtering techniques to solve the noisy problem.

Image de-noising is an vital image processing task i.e. as a process itself as well as a component in other processes. There are many ways to de-noise an image or a set of data and methods exists. The important property of a good image denoising model is that it should completely remove noise as far as possible as well as preserve edges. Traditionally, there are two types of models i.e. linear model and non-liner model. Generally, linear models are used. The benefits of linear noise removing models is the speed and the limitations of the linear models is, the models are not able to preserve edges of the images in a efficient manner i.e the edges, which are recognized as discontinuities in the image, are smeared out. On the other hand, Non-linear models can handle edges in a much better way than linear models.

The performance of these techniques is compared with respect to (i) PSNR value(ii) MSE Value. Image filtering techniques improve image quality, increase visibility of details, help in the diagnostic and accurate information in medical care.

II LITERATURE REVIEW

Florian Luisier and Michel Unser [1] proposed a general methodology(PURE_LET)to design and optimize a wide class of transform-domain thresholding algorithms for denoising images corrupted by mixed poisson gauss ion noise.

Aneesh Agrawal, Abha Choubey and Kapil Kumar Nagwanshi[2] describes the system presents a new technique for filtering narrow-tailed and medium narrow-tailed noise by a fuzzy filter. Lei Zhang et.al.[3] have developed an efficient image denoising scheme by using principal component analysis (PCA) with local pixel grouping (LPG).

Zhenghao Shi and Lifeng He [4] presented the application of artificial neural networks in medical image preprocessing, in medical image object detection and recognition. Di Jia et.al. [5] proposed a synchronization algorithm of denoising and contrast enhancement.In their work, the edge denoising and enhancement are completed with the improved PM model.

J. Najeer Ahamed[6] demonstrated the design of hybrid filter utilizes the concept of neuro fuzzy network and spatial domain filtering. This methodincorporates improved adaptive wiener filter and adaptive median filter to reduce white Gaussian noise and impulse noise

Aleksandra Pi zurica et.al.[7] proposed method for reducing adaptive Gaussian noise from digital greyscale images that the proposed method can efficiently and rapidly remove additive Gaussian noise from digital greyscale images.

Tanaphol Thaipanich et.al.[8] proposed an adaptive image denoising technique based on the nonlocal means (NL-means) algorithm. Nguyen Minh Thanh and Mu-Song Chen[9] presented a generalized fuzzy inference system (GFIS) in noise image processing. Paul Bao and Lei Zhang[10] proposed a wavelet-based multiscale products thresholding scheme for noise suppression of magnetic resonance images.

C. Tomasi, R. Mantachie (11), proposed a Bilateral Filtering for Gray and Color Images that *smooths* images while preserving edges, by means of a non linear combination of nearby image values. Pawan Patidar, Manoj Gupta, Sumit Srivastava, Ashok Kumar Nagawat (12), avoid Image noising by Various Filters for Different Noise.

III. THE PERFORMANCE EVALUATION CRITERIA

The performance of all the filtering techniques was evaluated using two different quantitative measures. 1.PSNR 2.MSE

PSNR is 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 a logarithmic decibel scale.

The *Mean Square Error (MSE)* and the *Peak Signal to Noise Ratio (PSNR)* are the two error metrics used to compare image quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE, the lower the error. To compute the PSNR, the block first calculates the mean-squared error using the following equation:

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M*N} \text{ ------------(1)}$$

In the previous equation, *M* and *N* are the number of rows and columns in the input images, respectively. Then the block computes the PSNR using the following equation:

$$PSNR = 10log_{10} \text{ -------------------(2)}$$

In the previous equation, *R* is the maximum fluctuation in the input image data type. For example, if the input image has a double-precision floating-point data type, then *R* is 1. If it has an 8-bit unsigned integer data type, *R* is 255, etc.

IV. LINEAR AND NON LINEAR FILTERING TECHNIQUES

A traditional way to remove noise from image data is to employ spatial filters. Spatial filters can be further classified into linear and non-linear filters. A. Linear Filters tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal dependent noise.

Mean Filters:

Mean filtering is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. The idea of mean filtering is simply to replace each pixel value in an image with the mean value of its neighbors, including itself. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel, which represents the shape and size of the neighborhood to be sampled when calculating the mean, the mask has a value of N/1, where N is the mask size.

Gaussian Filters:

The Gaussian smoothing operator is a 2D convolution operator that is used to 'blur' images, remove detail and noise [2]. In this sense it is similar to the mean filter, but it uses a different kernel that represents the shape of a Gaussian. In 2D, the Gaussian distribution follows the equation:

$$\frac{I}{2\pi\sigma^2} exp\left(-\frac{i^2+j^2}{2\sigma^2}\right) \text{ - - - - - - - - (3)}$$

Where σ is the standard deviation. The idea of Gaussian Smoothing is to use this 2D distribution as a point-spread Function; achieved by convolution. Once a suitable mask has been calculated, then the Gaussian smoothing can be performed using standard convolution.

Median Filters:

The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. Median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values; replace it with the median.

2D –Order statistics Filter:

The 2D order-statistic filtering is used to remove the noise and enhance the weak boundaries of medical images. The 2D order-statistic filtering replaces each pixel of an image by the nthorder element in the sorted set of neighbours of size r by specified by the nonzero elements in domain.

Bilateral Filter:

The bilateral filter is a nonlinear, feature preserving image filter, proposed by Smith and Brady and separately by Tomasi and Manduchi . Although, the filter is initially designed to be an alternative to anisotropic diffusion recent researches demonstrate that it has close connections with robust estimation and anisotropic diffusion and the output is a weighted average of the input. They start with standard Gaussian filtering with a spatial kernel f However, the weight of a pixel depends also on a function g in the intensity domain, which decreases the weight of pixels with large intensity differences.

Sticks Filter:

After an extensive research, a very strong edge preserving filter known as "sticks". This filter is well known in literature for its capabilities in detection of boundaries and lines in presence of multiplicative noise. In this case, to find the defected region in materials with a high accuracy, it is crucial to conserve all boundaries. To find the lines in the image, it is necessary to determine whether a line passes through each pixel. In sticks filter, a neighbourhood around each pixel is constructed and a search for lines passing through the center of that neighbourhood is performed. "This is an M-array hypothesis testing, where each of the hypotheses represents a possible line orientation" .For simplicity, the neighborhood can be considered to have a square shape. This way, the number of orientations is equal to the number of hypothesis. The set of hypotheses is called"sticks".

Im filter

Im filter is used to filter a multidimensional array with a multidimensional filter. The result obtained is of same size as the array specified. The parameters specified carry out the multidimensional filtering. The syntax for this is

A = Imfilter(Y, Z, type1, type2,…)

The values of type1 can be symmetric, replicate, circular, correlate, and type2 can be corr conv etc.

V RESULT AND DISCUSSION

The lung CT image is taken as a input image and this we add Gaussian noise and We apply various de nosing filter for the noisy image after that we calculate PSNR and MSE value for the denoised image and draw the performance evaluation table to compare the image quality.

Figure-1 Original image

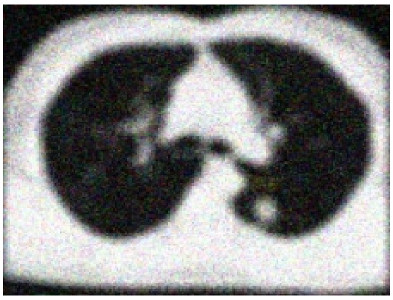


Figure-2 Noisy image

Figure 1 shows the original image and figure 2 shows the noisy image in this noisy we use various denoised filter like Gaussian ,Meadian Filter,Mean Filter,2D Order Statistics Filter , Bilateral filtering, ImFilter, Sticks filter.After denoised we get the denoised image for different filter.and we calculate PSNR and MSE value for all the denoised image.

For the various filtering techniques PSNR plot has been constructed.Figure 3 will shows the PSNR plot for various filtering techniques.In that, X-axis will shows the number of images and Y-axis indicates the PSNR values.From that, plot clearly indicates Imfilter having highest PSNR values than the Median and Gaussian, Mean, 2D order statistics filter, Bilateral filter and sticks Filter

VI CONCLUSION

This paper focus on efficient denoising and enhancement for medical image, the imfilterr will provide the efficient denoising. Present approach has implemented a contrast Enhancement and denoising technique ,and the medical image is given as the input, if the input image is colour image then it is converted in to gray scale in order to reduce the processing time the contrast of input image is enhanced and the image is denoised using various filter and the quality and accuracy is measured by PSNR and MSE value and we evaluated the best denoised image according to these value

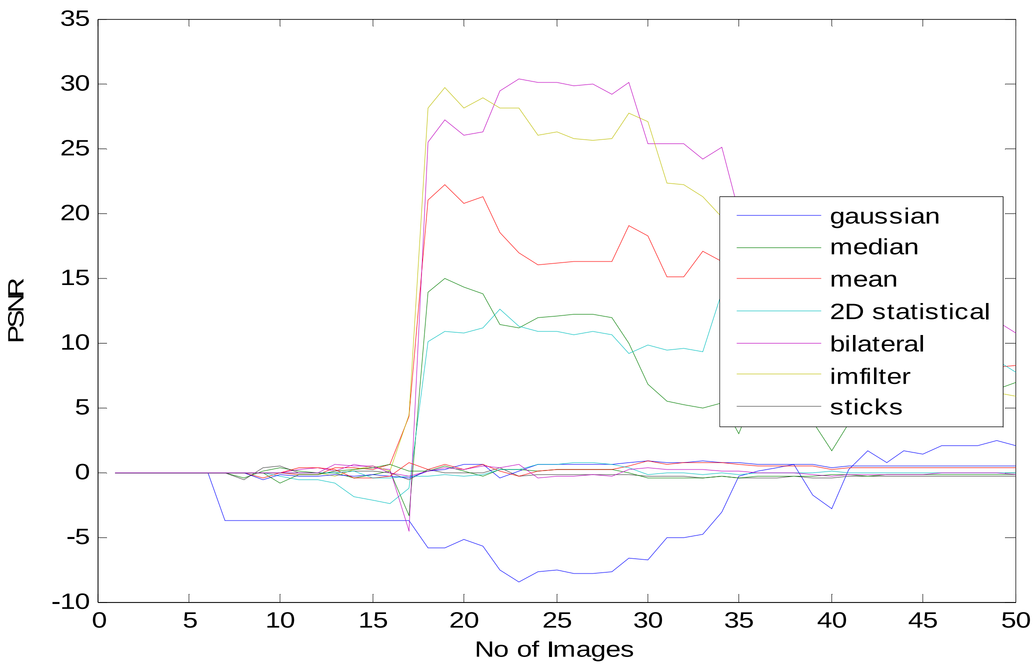
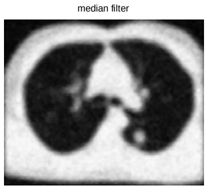
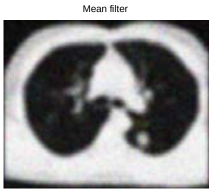
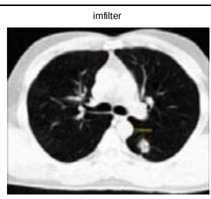


Figure-3

TABLE 1.PSNR RATIO AND MSE COMPARISON

Method	Noise Removal Effect	PSNR	MSE
Gaussian Filtering		16.8259	1.3505e+003
Median Filtering		9.5131 + 2.7288i	-1.1391
Mean Filters		15.0226 + 4.0931i	-0.6391
2D –Order statistics Filter		9.9884	1.6670e+005
Bilateral filtering		18.5085	1.3505e+003
ImFilter		24.7796 +68.2188i	-2.0773e+004
Sticks filter		18.5085	1.3505e+003

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