Comparative Study of Various Filtering Methods on 3D Medical Images Using Aphelion Dev Software

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Abstract- ***The diagnosis of medical image becomes more difficult with the presence of noise. It reduces the resolution of image which leads to problem in diagnosis of medical images. In this paper, the performance of various despeckling filters like Box, Convolution, Gaussian, Median, Mode and Rank Value have been analyzed for 3D-bone image. The statistical values such as mean, standard deviation, skewness and kurtosis have been considered to analyse the filters with help of Aphelion Dev software. This technique will helps to improve the appearance of 3D images and detects the presence of abnormalities during diagnosis.***

Keywords- ***3D Bone Image; Gaussian Filtering; Aphelion Dev.***

I.INTRODUCTION

3D medical image processing has evolved in recent year, leading to major improvement in patient care. 3D image processing provides an extensive set of tools for 3D volume calculation, measurements and quantitative analysis. 3D models of the patient have been supported to identify the abnormalities from anatomical structures, diagnosis and surgical simulation.

3D image processing provides an extensive set of tools for 3D volume calculation, measurement and quantitative. Computer aided techniques that reconstruct 3D models from a single or a few x-rays, describing both the patient-specific shape and bone density distribution of an anatomy of interest.

Aimilia Gastounioti et al, [1] described the diagnostic algorithm which has been used to identify stroke and Cerebrovascular Disease (CVD) earlier. Gray scale median has been used to identify the vascular disease and stroke prediction from Ultrasound Image Analysis.

Anisha.S.R et al, [2] developed a method to treating brain, prostate cancers, ankle and foot by using Magnetic Resonance Imaging (MRI). The various filters methods are used to remove the noise in brain image such as Wiener, Mean and Median filter. Buchanan.D et al, [3] explained the performance of algorithm to extract the Media–Adventitia Boundary (MAB) and Lumen–Intima Boundary (LIB). Semiautomated segmentation for delineating the MAB and LIB algorithm has been evaluated for 3D ultrasound images.

Constantinos Pattichis et al, [4] suggest various methods for visual classification and standardized methods for image acquisition. Image segmentation and denoising has been used for several texture-feature extraction and classification. Christos P. Loizou et al, [5] explained on 200 longitudinal-section ultrasound images from 150 normal subjects and 50 symptomatic subjects suffering with CVD. Gray Level Difference Statistics (GLDS) correlation has been used to differentiate between normal subjects and subjects suffering with CVD.

Deepa.P et al, [6] described various denoising filtering techniques such as Mean, Median, Gaussian and Bilateral filter for Computed Tomography (CT) image with a set of predefined noise levels. The result has been evaluated based on the parameters such as Peak Signal-to-Noise Ratio (PSNR) and Mean Square Error (MSE).

Efthyvoulos C. Kyriacou et al, [7] presented the performance of asymptomatic internal Carotid Artery Stenosis on the identification of plaques. The stoke prediction has been improved by Spatial Gray Level Dependence Matrices (SGLDM). Gastounioti.A et al, [8] explained the difference between motion and texture features of the diseased arterial wall. The various motions like velocity, amplitude and diastole-to-systole displacement, and texture features based on first- and second-order statistics have been estimated. The spearman rank correlation coefficient and the statistical significance have validated through permutation tests.

Llackiya.R et al, [9] developed Fractal Geometry, it is accurate to display a modelling of nature texture in a digital images. To extract or classify different texture images Segmentation based Fractal Texture analysis (SFTA) methods have been applied. Joao Sanches et al, [10] described the Degree of Stenosis (DoS) used to train and test a support vector machine (SVM) classifier using threefold stratified cross-validation. Plaque Risk Index (PRI) has been used to monitor variation in feature change as asymptomatic plaques become symptomatic.

Kumar et al, [11] explained the automatic dissection of brain neoplasms in MR images. Various segmentation and classification methods have been used such as pre-processing, Dissection, feature extraction, feature reduction. Jin Young Kim et al, [12] developed image segmentation techniques to diagnosis a disease from the carotid artery US images. Spatial, wavelets and gray level co-occurrence matrix (GLCM) features have extracted from ultrasound image. Intima-Media Thickness (IMT) measured values and Multi-Layer Back-Propagation Neural Networks (MLBPNN) have been used to classify the normal and abnormal images.

Oliver Faust et al, [13] explained the performance of different methods such as preprocessing, feature extraction and classification. The feature extraction uses image texture analysis to calculate standard deviation, entropy, symmetry, and run percentage. Adaboost and Support Vector Machine (SVM) have used for automated decision making.

Valavanis.I et al, [14] described the performance of different multiscale transforms such as dual-tree complex wavelet (DTCWT), the finite ridgelet (FRIT) and the Fast Discrete Curvelet (FDCT). Curvelet transform used to identify the presence of plaques accurately. Vinitha sree.S et al, [15] developed Computer Aided Diagnosis (CAD) algorithm classifies the patient into symptomatic and asymptomatic classes using two datasets. The gray scale Intima Media Thickness (IMT) region and plaque region in ultrasound carotid image have been segmented automatically. SVM and K-nearest neighbor (KNN) have been used to identify the plaque region.

In this paper, the performance of various filters such as Box, Convolution, Median, Mode, Rank value filter have been analyzed based on some statistical values like mean, standard deviation, skewness and kurtosis.

II METHODOLOGY

The flow of developed method is as shown in fig.1. and the steps involved in this work have explained as follows:

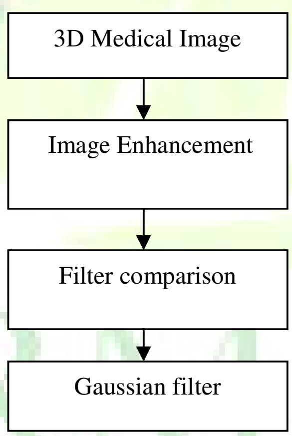


Fig.1. Flow diagram for developed method

2.1 Image Enhancement

Acquiring 3D medical images of diagnostic quality, although some radiological interventions are performed by radiologists. Image enhancement technique improves the quality of image for human viewing, removing blurring, increasing contrast.

2.2 Comparison of various filters

2.2.1 Box Filter

Box filter have been used to speed up many computation intensive operations in image processing and computer vision. They have the advantage of being fast to compute, but their adoption has been troubled by the fact that they present serious restrictions to filter construction. To performs a box filtering on a image using an arbitrary window size for the kernel. Each convolution coefficient in the kernel as follows:

$$\frac{1}{(boxsize * boxsize)} \quad (1)$$

The size of filter window has set by default to 3 for filter out the speckles.

2.2.2 Convolution (Low Pass) Filter

A low-pass filter is a filter that passes signals with a frequency lower than a certain cut off frequency and attenuates signals with frequencies higher than the cut-off frequency. The amount of attenuation each frequency depends on the filter design. Input pixel window is always the same size as the convolution mask. The output pixel is rounded to the nearest integer also calculated for the measurement of image quality performance. In convolution filtering, an image filtering has been performed based on a convolution using a predefined kernel. Kernel value is set default as 3x3.

2.2.3 Gaussian Filtering

The Gaussian filter replaces a value with the weighted average of it and the neighboring pixels; the weights fall off exponentially as the square of the distance divided by 2 times the square of sigma. It is used to attenuate speckle noise which presents in the ultrasound image without disturbing any important features of the image. It used for removing speckle in medical ultrasound images without compromising the accuracy and quality. It results the smoothed image of 3D medical images. The Gaussian distribution follows the equation:

$$\frac{1}{2\pi\sigma^2} \exp\left(-\frac{t^2 + f^2}{2\sigma^2}\right) \quad (2)$$

Where σ is the standard deviation desires the function of speckles present in 3D image.

2.2.4 Median Filtering

The median filter is a sliding-window spatial filter, but it replaces the centre value in the window with median of all pixel values in the window. Median filters operate by replacing a given sample in a signal by the median of the signal values in a window around the sample. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise like salt and pepper noise. It uses 3D parallelepiped window to process volume image elements. The median filter (M) can be implemented by the formula:

$$M(P1 \ldots PN) = Median(\| P1 \| 2 \ldots . \| PN \| 2) \quad (3)$$

2.2.5 Mode Filtering

Mode filtering techniques are used to reduce speckle in ultrasound images, to improve their suitability for later feature extraction. It has performed to mode filtering of an image; each pixel value with in a window of the image is repeated by the weight value in the corresponding element of the kernel. The mode is the value which occurs most often in the selected neighbourhood. When there is more than one value the mode has same population known as true multiple modes the order of choice is follows: If the central pixel is the same as one of the modes, the function chooses it. If not, then function select first occurring mode as scanned from the lower left to the upper right of the window.

2.3.6 Rank Value Filtering

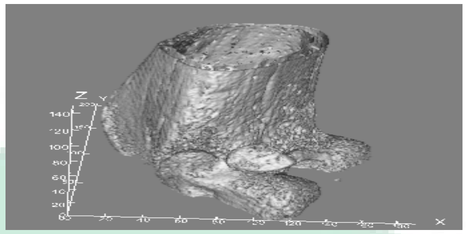
The performance of rank filtering on an image is using predefined kernel. The function counts each pixel value with in the window using the corresponding weight specified in the mask kernel. It then sorts the value from least to greatest and selects the value at the rank index. The selected value occurs at rank position of the population when the function sorts by value. Mask value are integers which indicate the function counts each underlying pixel value as part of the population. When there is an even population, the algorithm selects the value of the individual on the lower side of the middle. The kernel value is set default as 3x3.

$$I_1 \le I_2 \le I_3 \le \ldots . \le I_{N^2} \quad (4)$$

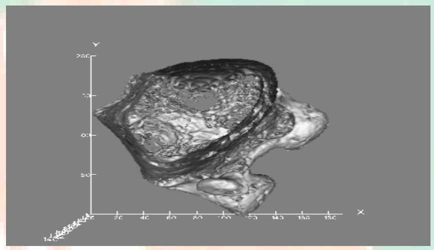
Where I_1….I_3… I_{N^2} are intensity values.

III. RESULTS AND DISUCSSION

The 3D bone image has been obtained from the various filters. The longitudinal section acquired input image as shown in fig.2a. Fig.2b shows the Box filtered image using the window size of 3 which is used to enhance the contrast of input image. The convolution low pass filtered image is shown in fig.2c which has the kernel size of 3x3. The output of Gaussian filtering image with the width of Gaussian shape is 3 as shown in fig.2d. It is used to remove the speckles which present in image region due to low echoes of US scanner. Fig.2e shows the median filtering output image with the kernel value of 3. Fig.2f shows the despeckling image using mode filtering which has the window size of 3x3. The output image from Rank value filtering is shown in fig.2g which has the rank value of 3.

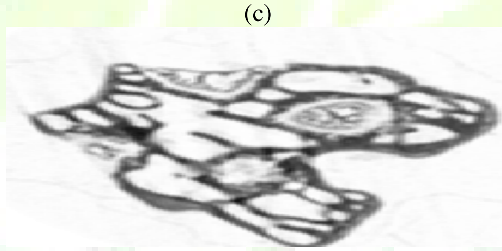


(a)

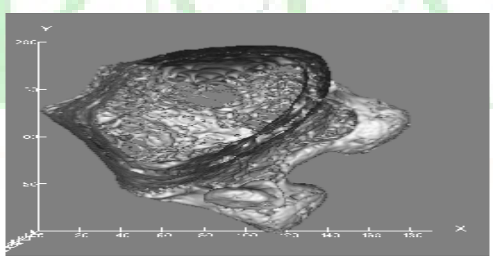


(b)

(c)



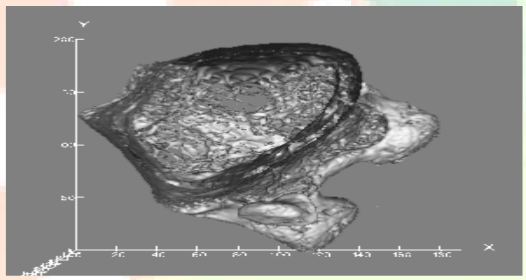
(d)



(e)

(f)

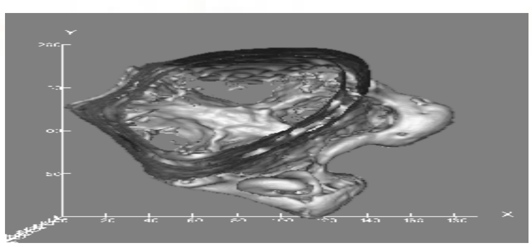
(g)



(h)

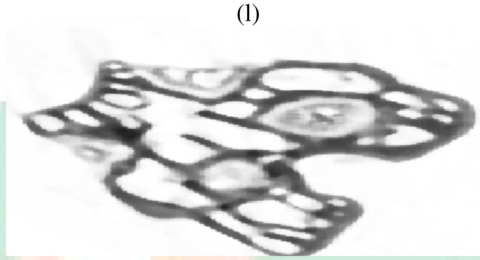
(i)

(j)

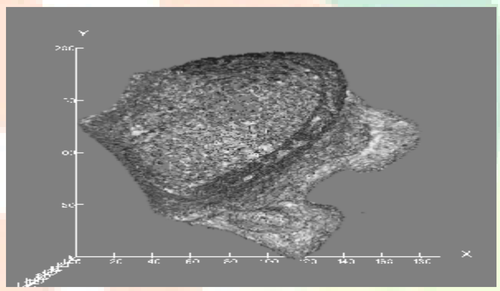


(k)

(l)



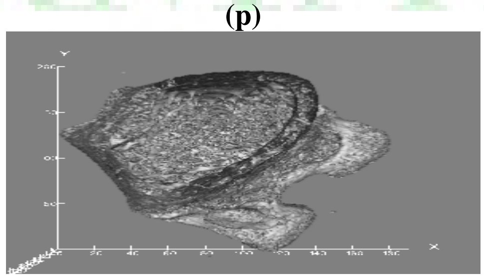
(m)



(n)

(o)

(p)



(q)

(r)

(s)

Fig.2.(a)Input Image, (b) box filter output(ISO surface), (c) box filter output(volume),(d)box filter output (slice),(e) convolution output(ISOsurface),(f) convolution output (volume), (g) convolution output (slice), (h) median filter output(ISO surface), (i) median filter output (volume), (j) median filter output (slice), (k) mode filter output(ISO surface), (l) mode filter output (volume), (m) mode filter output(slice),(n) Gaussian filter output(ISO surface), (o) Gaussian filter output (volume), (p) Gaussian filter output (slice), (q) Rank value filter output(ISO surface), (r) Rank value filter output (volume), (s) Rank value filter output (slice).

TABLE I. DESPECKLING RESULTS OF DIFFERENT FILTERING

Filter Type	Mean	Standard Deviation	Skewness	Kurtosis
Box	233.4164	43.388	2.495	5.140
Convolution (Low Pass)	233.5911	44.148	2.515	5.174
Gaussian	238.6189	47.900	2.827	6.450
Median	237.2123	43.670	2.665	5.816
Mode	233.3735	44.446	2.519	5.174
Rank value	234.638	47.332	2.590	5.396

The statistical parameters such as mean, standard deviation, skewness and kurtosis for different filtering techniques are obtained as shown in table.1. The comparative analysis shows that the gaussian filtering provides better speckle reduction than other techniques. The value of standard deviation for the Gaussian filter (47.9) provides better unspeckled result than other filters.

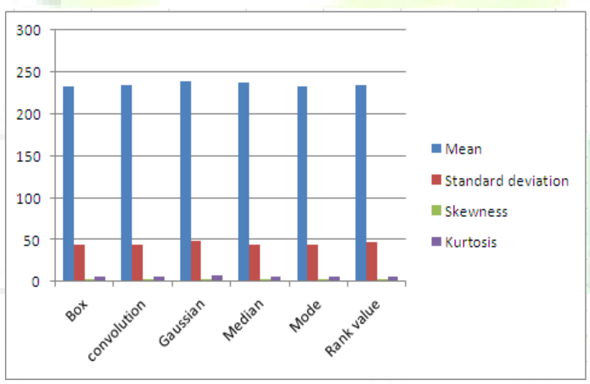


Fig.3. Performance Analysis of Various Filtering

The comparative analysis of various filter parameters has shown in fig.3. From this graph performance of Gaussian filter is superior when compare to other filters because it has higher noise reduction then other techniques.

IV. CONCLUSION

The speckle noise reduction is an important process in the diagnosis of 3D-bone image. Image has been filtered using different methods such as Box, Convolution (low pass), Median, Mode, Gaussian and Rank value. The performances were analyzed using statistical values like mean, standard deviation, skewness and kurtosis with the aid of aphelion Dev software. The comparison of results shows that Gaussian filtering is more suitable for higher noise reduction than other techniques.

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