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Image Enhancement of DICOM Lung Cancer

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Abstract___ lung cancer images have the ability to help detecting on disease caused by cells normal growth. During this study we will deal with DICOM images which have a standard for medical imaging. Its purpose is to standardize digital medical imaging and data for easy access and sharing. The DICOM images suffer from a poor contrast quality and noises. So we need to remove the noise from the image before improving the contrast of image. In this paper we use the better filters to remove the noise and enhancement the contrast of DICOM images on lung images.
Keywords--- DICOM, Image enhancement, lung cancer, histogram equalization, Noise.

I.   INTRODUCION

Cancer is a collection of diseases that cells in the body to grow out of control and change. Most types of cancer cells eventually form a masses or lump called a tumor, and are named after the part of the body where the tumor originates. Early detection is the most effective to reduce mortality, and currently a screening programmer based on CT is considered one the popular for detection of lung cancer [1]. As digital technologies are incorporated in every aspect of our lives, they are also the key part of medical diagnosis. DICOM (Digital Imaging and Communication in Medicine) standard was developed to make sharing of medical information safe [2]. A DICOM image supports gray scale and color images of different formats. Besides image data , DICOM includes image – related data that are stored in the header of an image file. Some of the information included in the header is image resolution, image type, number of stored bits, etc.

II.   MATERIAL AND METHOD

The database of CT lung used in this work is acquired from Dr. M. Morsy. The entire method presented in this paper was implemented using MATLAB7.0, and makes extensive use of the image processing toolbox. Is shown fig. 1 which consists of three main steps: Firstly, we apply the processing stage. Secondly, we apply noise removal stage and finally, the enhancement stage.
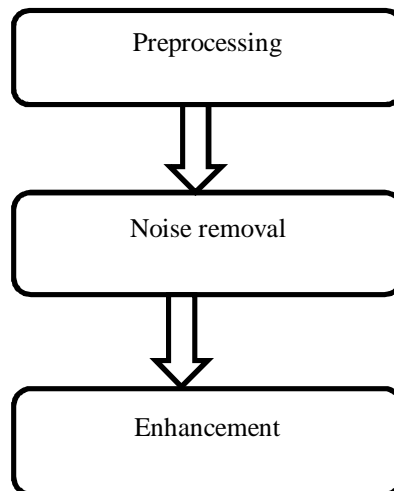
Preprocessing

↓

Noise removal

↓

Enhancement

Fig.1: Proposed Algorithm

A.   Preprocessing

The preprocessing stage is the first stage in proposed algorithm which uses to correct displaying of DICOM image and it involves six steps as shown in fig.2.

184

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Fig.2. the structure of preprocessing stage

Step1 Of the preprocessing stage is reading the images from DICOM files and we used dicomread function in MAT LAB image processing toolbox. As shown in fig.3 the DICOM image has poor contrast and its histogram is very narrow.

(a)   Original image   (b) Histogram of original image
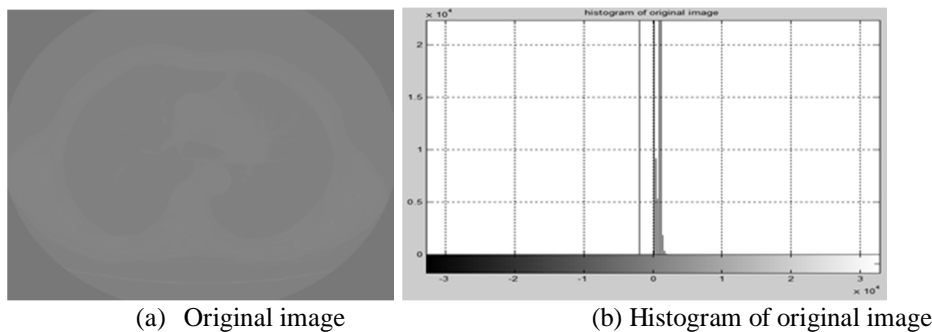
Fig.3 Read the DICOM image

Aims to convert a data matrix to a gray scale image whose values represent intensities within some range. MAT LAB mat2gray function in mat lab image processing toolbox which converts the matrix of the input image to the intensity image [3].As shown in fig.4 the image become very clear compared with the original image in the previous image and histogram wide compared with the histogram shown in fig4.

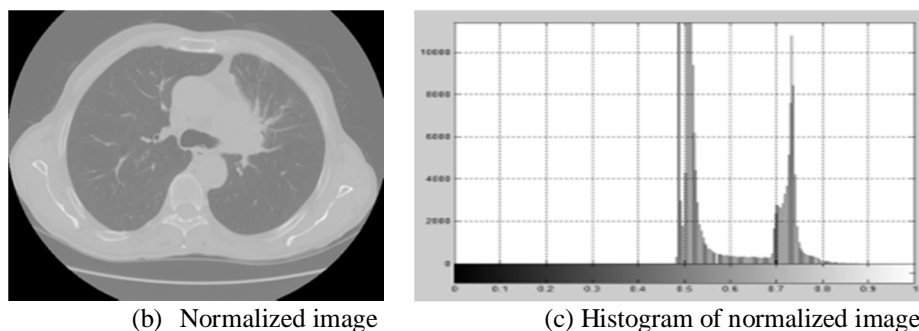(b)   Normalized image   (c) Histogram of normalized image

Fig.4 normalized the original image

Step 2 Aims to selection the region of interest (ROI) which is portion of an image that contains the important data needed in our

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studying and we used the mat lab function as shown in the following command. Where, F=output image and I = input image.

$$F= imadjust (\quad I, [gray1\ gray2], []);$$

gray1 and gray2 are selected by using imcontrast which creates an adjust contrast tool in a separate fig .As shown in fig.5 (a) the image consists of three regions and we need to select the region which contains the tumor and has high contrast. Now we will try to find this region by gray1 and gray2.
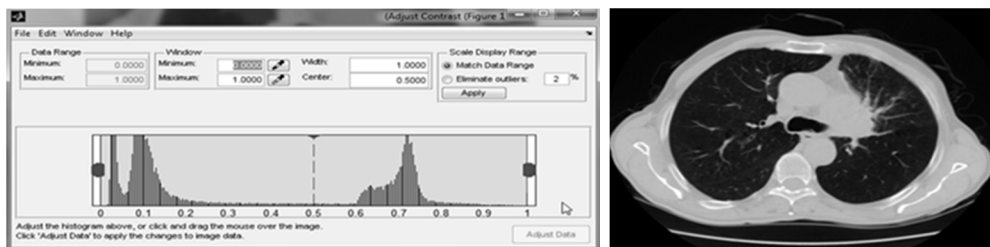
(a)   Target figure with gray1= 0.000 and gray2=1.000   (b) Adjusted image

Fig.5 adjusted image where gray1=0.000 and gray2=1.000

When we use the gray1 =0.000 and gray2=0.2102 as shown fig.6 (c) the result image is very brightness and (b) all the data hidden. (a)Target figure with gray1=0.000 andgray2=0.2102 (b) Histogram of enhanced image   (c) result image
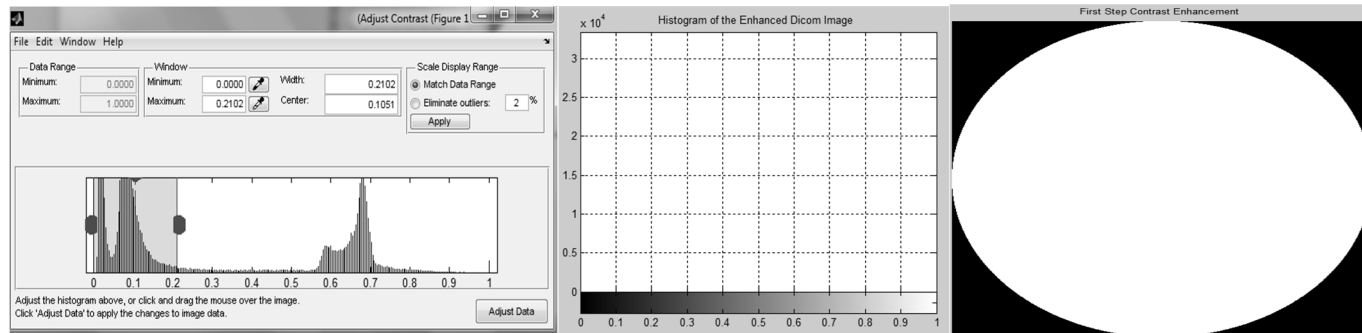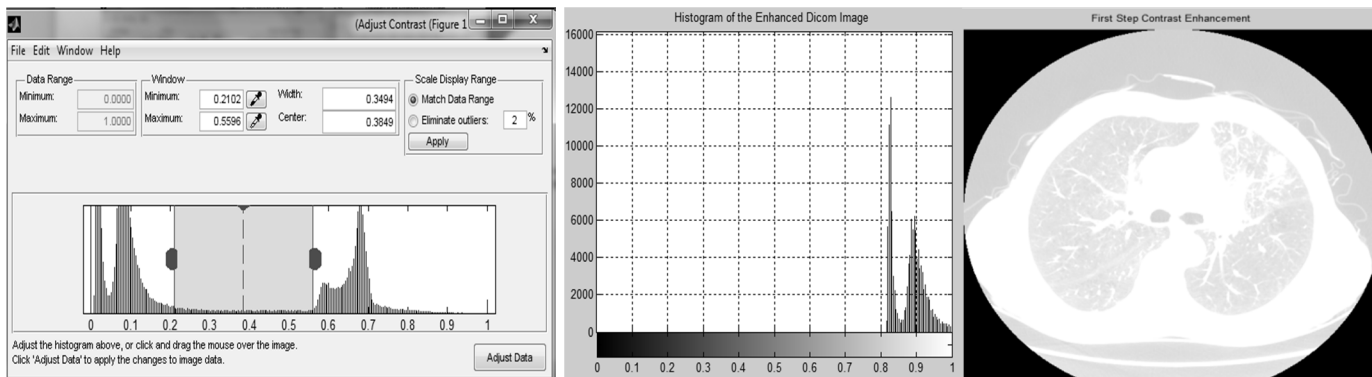

Fig.6 Image contrast image

When we use the gray1 =0.000 and gray2=0.2102 as shown fig.6 (c) the result image is better than previous image but the tumor is still unclear (b) all the data between 0.8 to 1 .

(a)Target figure with gray1=0.2102 andgray2=0.5596 (b) Histogram of enhanced image   (c) result image

Fig.7 Image contrast analysis

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When we use the gray level from 0.2853 to 0.9359 as shown fig. 8 (c) the result image is better than previous and the tumor is clear (b) the data is clear between0.35 to 0.9
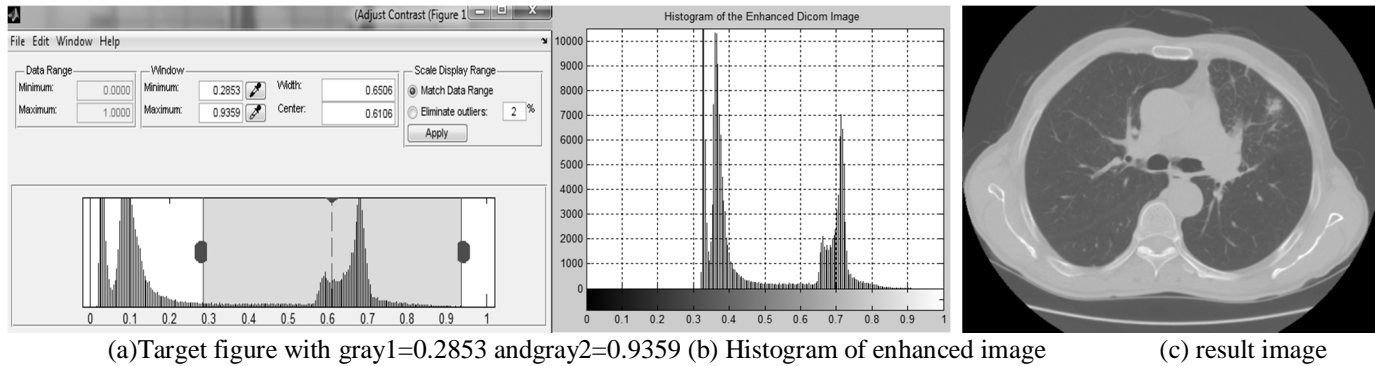

(a)Target figure with gray1=0.2853 andgray2=0.9359 (b) Histogram of enhanced image   (c) result image

Fig.8 Image contrast analysis

Step3 when we use the gray level from 0.2853 to 0.9359 the result region as shown in fig. 8

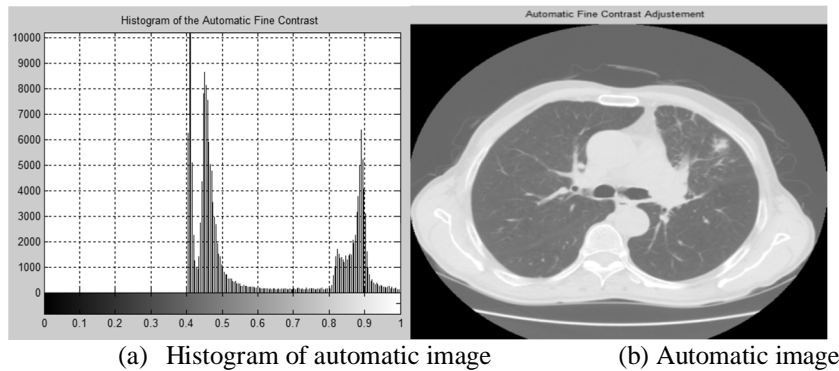(a)   Histogram of automatic image   (b) Automatic image

Fig. 9 Automatic fine contrast adjustment

Step 4 when we use the previous region the resulted of selective fine contrast adjustment in shown fig. 9

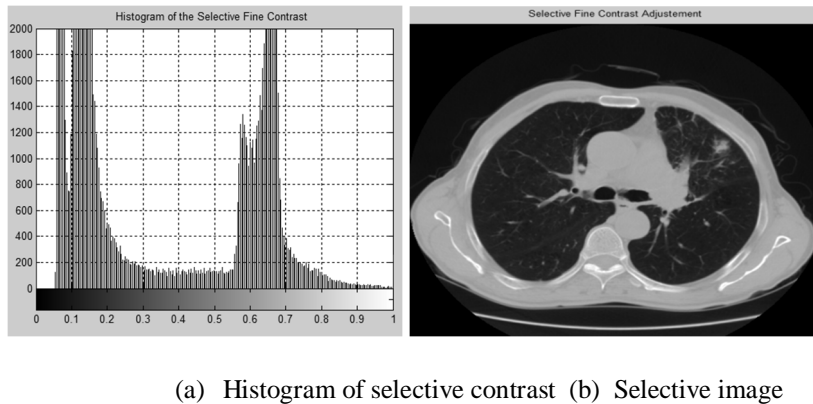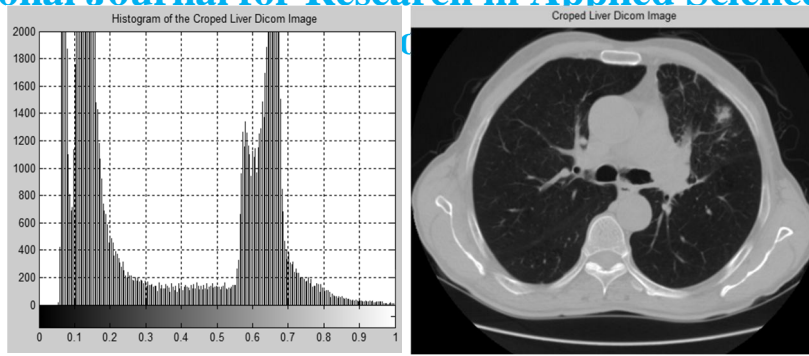(a)   Histogram of selective contrast (b) Selective image
Fig. 9 Selective fin contrast adjustment image

Step5 after that the unnecessary area of image is cropped by imcrop function of mat lab software. The result of this step in fig.10 .The New Image Size after Crop are   396   497.

(a) Histogram of cropped image   (b) cropped image

Fig.10 Crop the image

Step6 Save the image we used dicomwrite function.

Step7 close the program.

B. Noise removal

The second stage of proposed algorithm is a noise removal, which aims to reduce the noise of images. Medical images are subjects to a wide variety of distortions during processing, acquisition and transmission any of which may result in a degradation of visual quality. Images such as, computed tomography, ultrasound magnetic, etc.. Noises involve Gaussian noise and speckle noise. Normally, low quality images are not effective and very difficult to measure so there is an important need of noise reduction from medical images [4].We reduced noise from the images by two steps. Firstly, we add two types of noise with different variance to image because the noise of the original image doesn't appear. Secondly, noisy images are passing through different filters. Selecting the best filter which produces the best results depends on its parameter.

1) Generation of noisy image: Although speckle noise and Generation noise can superficially similar in an image, they are a result of different processes and need different approaches for their removal [8]. If the only degradation present in an image, G(x, y), is additive noise then:

$$G(x, y) = f(x, y) + n(x, y) \qquad (1)$$

When an image, f(x, y), is contaminated by multiplicative or speckle noise then:

$$G(x, y) = f(x, y) * n(x, y) \qquad (2)$$

Where f(x, y) is the original image and n (x, y) is the noise.

2) Denoising techniques: Filtering is a neighborhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel [5]. In this study we used three types of filter as follows:

a) Gaussian filter: Gaussian smoothing is law- pass filtering, which suppresses high frequency details which includes noise and also edges, while preserving the low frequency components of the image, which don't very too match [6]. This means they are linear filter and it is given by the equation:

$$G(x, y) = \frac{1}{2\sigma\pi} \exp \frac{-x^2 + y^2}{(2\sigma^2)} \dots\dots \quad (3),$$

The mask size is the function of σ. It controls the amount of smoothing, as σ increases more samples must be obtained to represent the Gaussian function accurately.

b) Median filter: Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. The best known order statistics filter is the median filter, which as its name implies replaces the value of a pixel by the median of the grey levels in the neighborhood of that pixel [7].

$$F(x, y) = \text{median } \{g(s, t)\}\dots\dots\dots\dots (4),$$

The original value of the pixel is included in the computation of the median. Median filters are quite popular because, for certain types of random noise, they provide excellent noise- reduction capabilities, with considerably less blurring than linear smoothing filters of similar size [7].

188

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

c) *Wiener filter:* The goal of the wiener filter is to filter out noise that has corrupted a signal. It is based on a statistical approach. Typical filters are designed for a desired frequency response. Wiener filters are characterized by the following:

   i)   Assumption: signal and (additive) noise are stationary linear stochastic process with known spectral characteristic or known autocorrelation and cross correlation.

   ii) Requirement: the filter must be physically realizable (this requirement can be dropped)

   iii) Performance criterion: Minimum Mean Square Error (MMSE). The orthogonally principle implies that the wiener filter in Fourier domain.

3) *Evaluation metrics:* The MSE and PSNR are the two error metrics used to compare image reconstruction quality. The higher value of PSNR denotes the better the quality of the reconstructed image [10].

$$PSNR = 10\log_{10}\left(\frac{1}{MSE}\right) \; db \dots\dots\dots\dots (5),$$

The MSE represents the cumulative squared error between the reconstructed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE indicates the lower of the error.

$$MSE = \sum_{x=1}^{m}\sum_{y=1}^{n}\frac{f(x,y)'}{m*n} - \frac{f(x,y)}{m*n}\dots\dots\dots\dots.. (6),$$

C. Enhancement of image

The final step of our proposed algorithm is to enhance of the dicom images by using different image enhancement techniques which are a group of image processing methods that could enhance digital images to make better visualization for radiologists. Some enhancement techniques such as: histogram equalization, adaptive histogram equalization.

1) *Histogram equalization:* There are many applications, wherein we need a flat histogram; this cannot be achieved by histogram stretching [8]. A perfect image is one which has equal number of pixels in all its grey levels. Hence our objective is not only to spread the dynamic range, but also to have equal pixels in all the grey levels. This is called as histogram equalization [8]. So we need a transformation that would transform a bad histogram to a flat histogram. The transformation that we need must satisfy the below two conditions. We know s = T(r) for 0≤r≤1

2) *Adaptive histogram equalization:* Adaptive histogram equalization operates on small regions in the image called tiles rather than the entire image. Each contrast of tiles is enhanced, so that the histogram of the output region approximately matches the uniform distribution or Rayleigh distribution or exponential distribution.
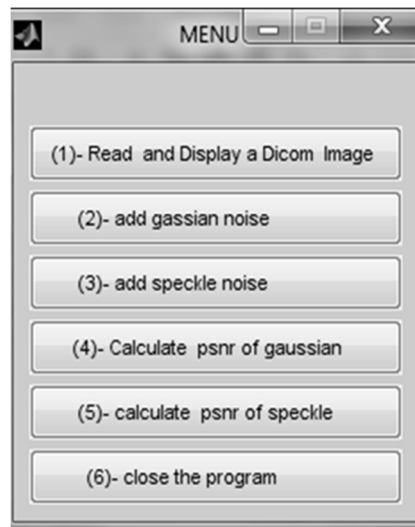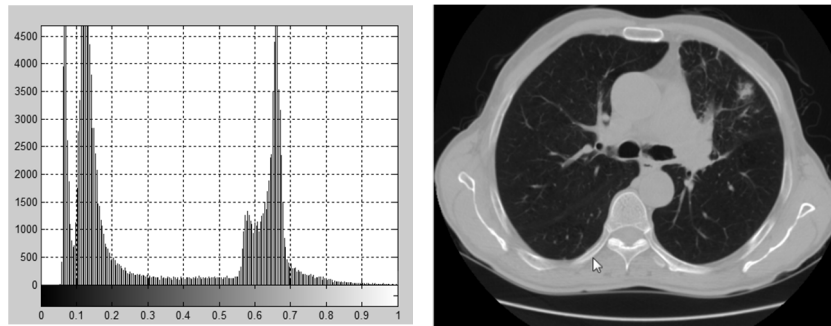
III.   RESULTS ANF DISCUSSION

Fig.11 Analysis of generates the noise

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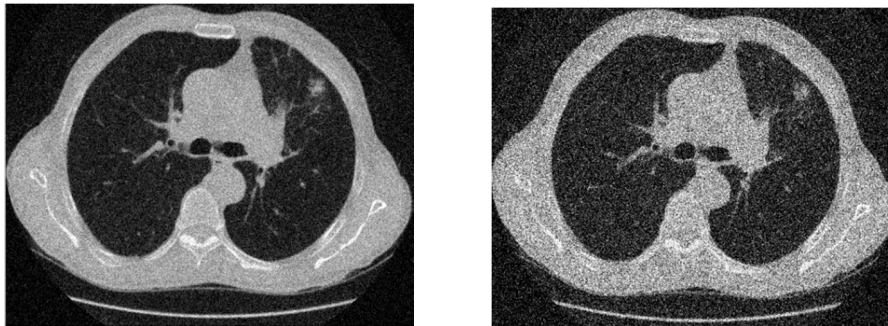
Step1 Read the proposed image using dicomread function in mat lab software as shown in fig. 12

(a) Histogram of proposed image   (b) Proposed image
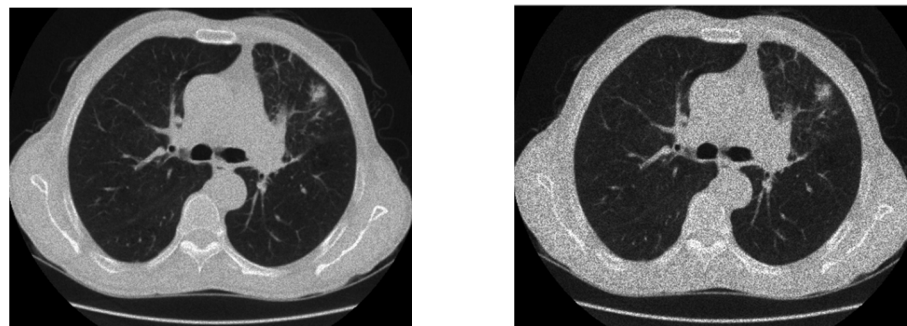
Fig.12 Read ROI image

Step2 Add Gaussian noise with different variances to the image (var=0.01 and var=0.05) as shown in fig.13

(a) Add Gaussian noise (var=0.01) to image   (b) Add Gaussian noise (var=0.05) to image

Fig.13 addition Gaussian noise to image

Step3 Add speckle noise to image with different variance (0.01 and0.05) as shown in fig.14

(a) Add speckle noise (var=0.01)   (b) Add speckle noise (var=0.05)

Fig .15 Addition speckle noise to the image

Step 4 Calculate the PSNR and MSE of the image as shown in table (1) using three filters Gaussian, Median and Wiener filters where additive the Gaussian noise .Based on the results the wiener filter is the best filter.

Table (1): image quality parameters after applying Gaussian noise and filtered image

Noisy image	Gaussian filter		Median filter		Wiener filter	
	PSNR	MSE	PSNR	MSE	PSNR	MSE
0.01	22.3596	0.0058	20.9167	0.0081	22.8086	0.0052
0.05	16.4541	0.0391	14.7276	0.0337	17.0895	0.0195

190

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Calculate the PSNR and MSE of the image as shown in table (2) using three filters Gaussian, Median and Wiener filters where additive the speckle noise. .Based on the results the wiener filter is the best filter.

Table (2): image quality parameters after applying speckle noise and filtered image

Noisy image	Gaussian filter		Median filter		Wiener filter	
	PSNR	MSE	PSNR	MSE	PSNR	MSE
0.01	25.1102	0.0031	27.8181	0.0017	31.1310	7.7073e-004
0.05	19.0604	0.0124	20.9718	0.0080	26.8919	0.0020

From the comparison tests that result in table1, table2, table3 and table4 we see the psnr and mse for every filter, the results show that the *wiener filter* has the highest psnr and lowest mse. Where we compared the results with the old results in years' ago [10] . For example in it:

Table (4) : Results from old paper (Gaussian noise)

COMPARISON OF PSNR AND RMSE VALUES FOR GAUSSIAN NOISE

	PSNR	RMSE
Median filter	33.0336	5.5658
Gaussian filter	33.2484	5.4157
Wiener filter	34.2525	4.8229
Average filter	33.2805	5.4056

Table (3) : Results from old paper (speckle noise)

COMPARISON OF PSNR AND RMSE VALUES FOR SPECKLE NOISE

	PSNR	RMSE
Median filter	33.8149	5.0891
Gaussian filter	33.0550	5.5266
Wiener filter	34.4384	4.7228
Average filter	33.8463	5.0450

So the images are passing through it as shown in fig. 17 . After that we enhance the contrast of image by enhancement techniques.

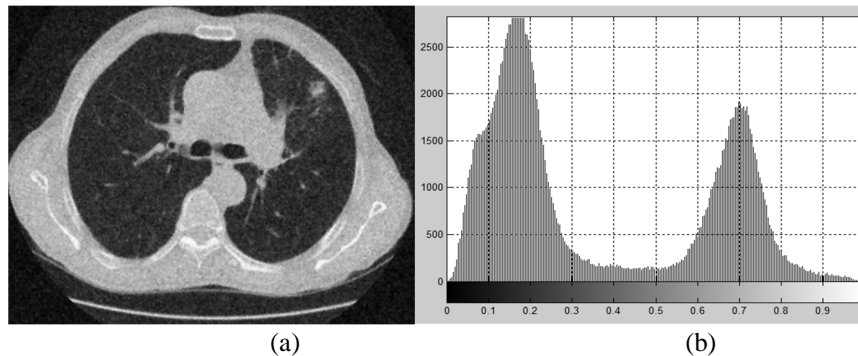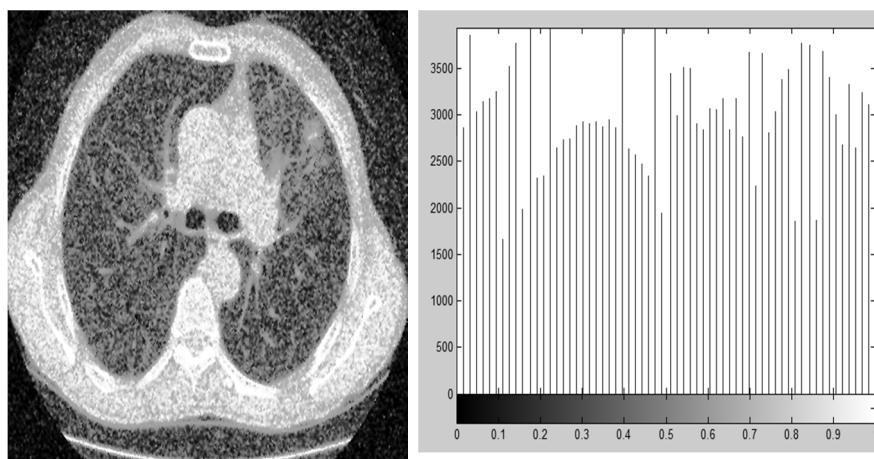(a)   (b)

Fig. 17 (a) filtered image, (b) histogram of image

Fig18 shows the results of histogram equalization and adaptive histogram equalization. The techniques improved the contrast of the tumor, however, introduced some noise to the image .

191

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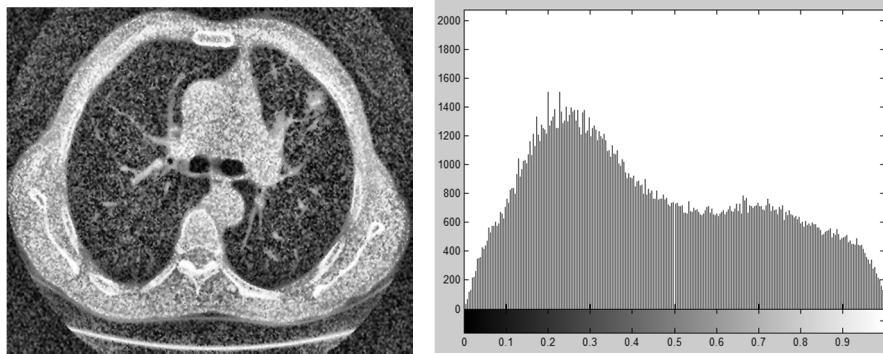

Fig.18 (a) equalized image, (b) histogram of equalized image,(c) adapted equalized image,(d) histogram of equalized i mage.

IV.   CONCLUSIONS

In our method a digital medical image processing uses denoising and image enhancement techniques to reveal any tumors that may not be obvious and to improve the image quality of DICOM breast image such that the resulting image is better than the original. Also from the above study the wiener filter is the best filter to remove the noise from the image and adaptive equalization is used to contrast image for detection of tumor.

V.   FUTURE WORK

We will develop an algorithm for lung segmentation and extraction the tumor using some methods.

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192

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