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Comparative Analysis of Image Enhancement Techniques to be used in Medical Images -A Survey

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ABSTRACT: Today almost every Human in the world wants their health records to be precise and truthful. Consequently the medical field required to use image enhancement technique for various reasons like it is possible to remove the noise from X-ray images to enhance contrast for better interpretation, sharping details of an image to improve the visual representation, sharpen the edges to increase the contrast between suspicious regions and the background so that the doctors can diagnose and treat human diseases. In this paper a survey of various image enhancement techniques is studied to focus on the development of image processing in medicine and healthcare.it is the milestone for analysing all the techniques in image enhancement in digital image processing.

Keywords: Image Enhancement, Digital image processing (DIP), spatial domain, Frequency domain.

I. INTRODUCTION

Digital image processing is a broad subject and often involves procedures which can be mathematically complex, but the central idea behind digital image processing is quite simple. The ultimate aim of image processing is to use data contained in the image to enable the system to understand, recognize and interpret the processed information available from the image pattern. Image Enhancement is the improvement of digital image quality, without knowledge about the source of degradation. Image Enhancement is the technique to improve the interpretability or perception of information in images for human viewers [1]. The main purpose of image enhancement is to bring out detail that is hidden in an image or to increase contrast in a low contrast image. Whenever an image is converted from one form to another such as digitizing the image some form of degradation occurs at the output. Basically, the idea behind enhancement techniques is to bring out detail that is obscured [2]. Enhancement may be used to restore an image that has suffered some kind of deterioration due to the optics, electronics and/or environment or to enhance certain features of an image. Image Enhancement is one of the most important and difficult techniques in image research. Many images like medical images, satellite images, aerial images and even real life photographs suffer from poor contrast and noise. It is necessary to enhance the contrast and remove the noise to increase image quality. One of the most important stages in medical images detection and analysis is Image Enhancement techniques which improve the quality (clarity) of images for human viewing, removing blur and noise, increasing contrast, and revealing details are examples of enhancement operations. The enhancement technique differs from one field to another according to its objective. Image enhancement can be classified into two categories:

1. Intensity Transformation and Spatial Filtering
2. Filtering in the Frequency domain

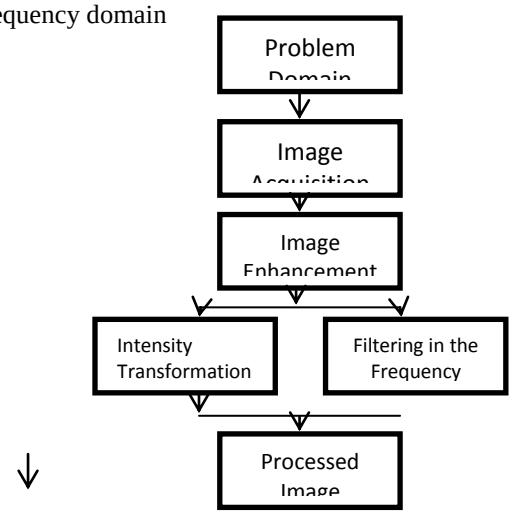

Figure1.Classification of Enhancement Technique

II. Intensity Transformation

The term spatial domain refers to the aggregate of pixels composing an image. Spatial domain methods are procedures that operate directly on these pixels. Spatial Domain processes will be denoted by the expression

$$g(x,y)= T[f(x,y)]$$

Where g(x,y) is an output image, f(x,y) is an input image and T is an operator on f (or a set of input images), defined over the neighbourhood of (x,y).

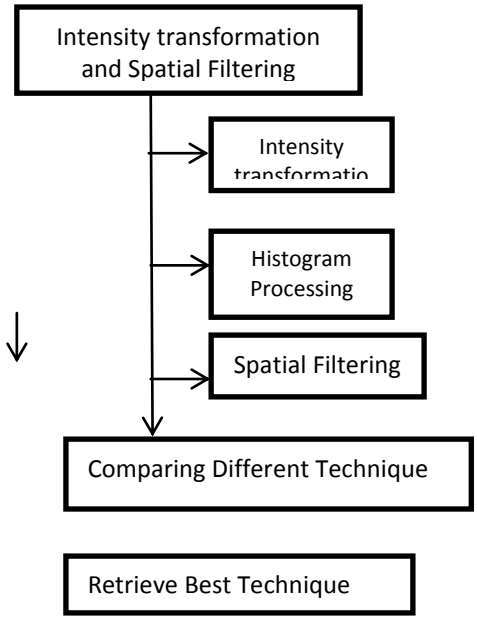

Figure 2.Intensity and spatial filters

III. Point processing

Enhancement at any point in an image depends only on the gray level at that point .In this case g depends only on the value of f at (x, y) and T becomes a gray-level transformation function of the forms s=T(r)

IV. Contrast stretching

Increasing contrast means increasing the gray level difference between neighbor pixels T(r).

V. Log Transformations

The general form of the log transformation is s=clog(1+r) Where c is constant and it is assumed that r>-0

VI. Image Negative

The negative of an image with gray levels in the range [0,L-1] is obtained by using negative transformation s=L-1-r

VII. Power-law transformation

The basic form $s=cr^r$ when c and r are positive constant power law curve with fractional values of r map a narrow range of dark input into a wider range of output with the opposite being the true for higher values of input levels

VIII. Piecewise transformation

The idea behind the contract stretch is to increase the dynamic range of the gray levels in the image being processed.

IX .Histogram Processing

The histogram of a digital image with gray levels in the range [0, L-1] is a discrete function $h(r_k)=n_k$ where r_k is the kth gray level and n_k is the number of pixel in the image having the gray level r_k

X. Filtering the frequency

The French mathematician Jean Baptist Joseph Fourier was born in 1768 in the town of AUXERRE about midway between Paris and Dijon. The Fourier contribution in these particular fields' states that any function that periodically repeats itself can be expressed as the sum of sines and/or cosines of different frequencies each is multiplied by different co-efficient .Fourier initial ideas were in the field of heat diffusion. The Fourier techniques provide a meaningful and practical way to study and implement a host of image enhancement approach.

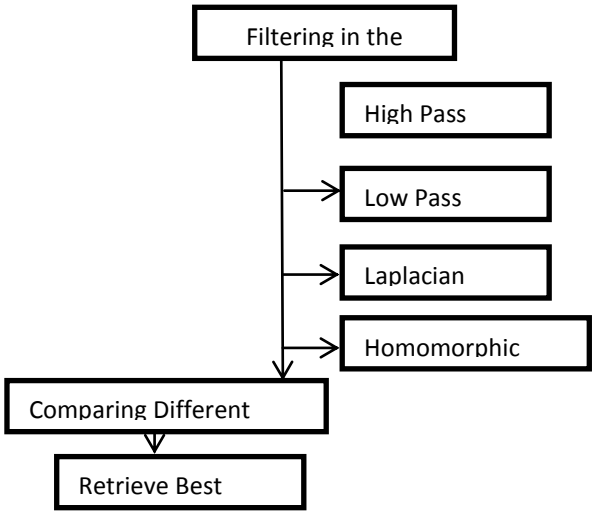

Figure3 Frequency filtering

XI. APPLICATIONS

Image enhancement is used for enhancing a quality of images. The applications of image enhancement are Aerial imaging, Satellite imaging, Medical imaging, Digital camera application, Remote sensing. Image Enhancement techniques used in many areas such as forensics, Astrophotography, Fingerprint matching, etc.

IE techniques when applied to pictures and videos help the visually impaired in reading small print, using computers and television, and face recognition. Colour contrast enhancement, sharpening and brightening are just some of the techniques used to make the images vivid. In the field of e-learning, IE is used to clarify the contents of chalkboard as viewed on streamed video; it improves the content readability. Medical imaging uses this for reducing noise and sharpening details to improve the visual representation of the image. This makes IE a necessary aiding tool for reviewing anatomic areas in MRI, ultrasound and x-rays to name a few. In forensics IE is used for identification, evidence gathering and surveillance. Images obtained from fingerprint detection, security videos analysis and crime scene investigations are enhanced to help in identification of the culprits and protection of victims.

XII. Experimental Result.

All the Algorithms are implemented in MATLAB R2016a tool which are at the END.

The Algorithms which are implemented are

- Point processing.
- Contrast Stretching
- Logarithmic
- Negative image
- Power-law transformation
- Piecewise –linear
- Histogram processing
- Histogram processing
- Histogram Equalization
- Spatial Filtering
- Linear spatial filtering
- Laplacian filter
- Diagonal filter
- Sobel operator

XIII. CONCLUSION

Image enhancement algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable images. The choice of such techniques is a function of the specific task, image content, observer characteristics, and viewing conditions. Most of the techniques are useful for altering the gray level values of individual pixels and hence the overall contrast of the entire image. But they usually enhance the whole image in a uniform manner which in many cases produces undesirable results. There are various techniques available which produce highly balanced and visually appealing results in a diversity of images with different qualities of contrast and edge information and it will produce satisfactory results.

XIV. ACKNOWLEDGEMENT

I wish to thank all the resources and specially the MATLab tool where I executed all the functions and all friends for helping in providing the information

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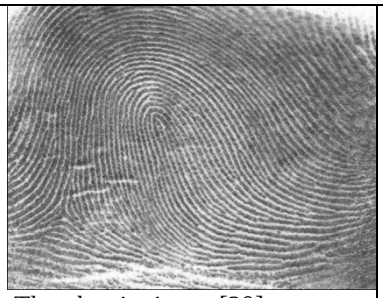
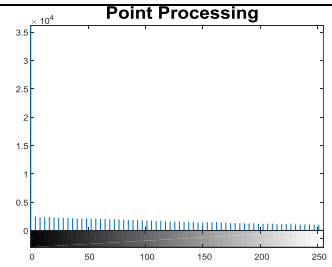
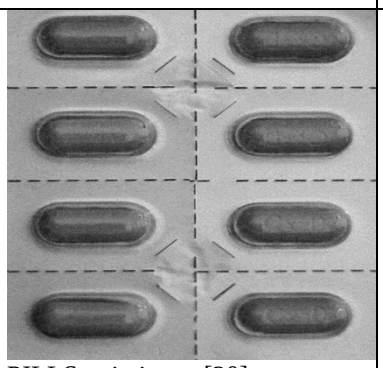
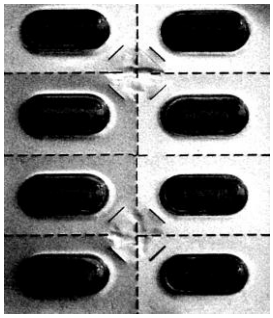
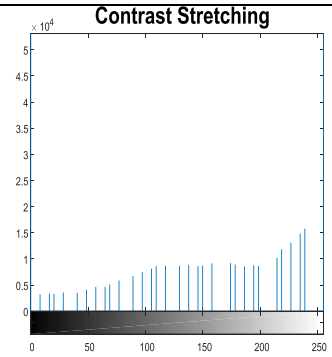
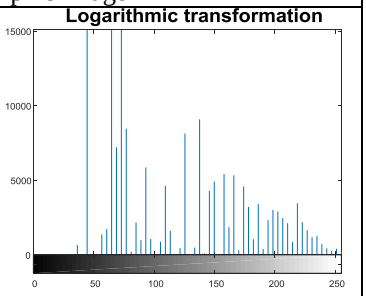
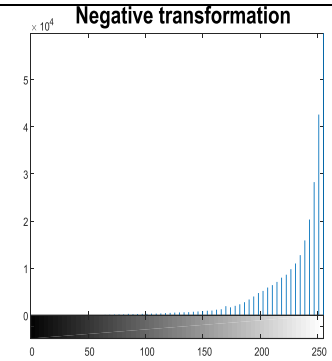
[21]. https://www.mathworks.com for MATLAB R2016a tool

RESULTS of Algorithms

Algorithm	Original Image	Image Enhancement	Graphs
Intensity Transformation			
Point Processing	 Thumb print image[20]	 Pixel processing of thumb print image	 Histogram of point processing of thumb print image after execution
Contrast Stretching	 PILLS strip image[20]	 Contrast stretched image of pills strip	 Histogram of contrast stretching of pills image
Logarithmic	 Left hand –xray image[20]	 Left hand –xray image for log function	 Histogram of Left hand –xray image for log function
Negative image	 Bone –scan image[20]	 Negative of Bone –scan image	 Histogram of Bone –scan

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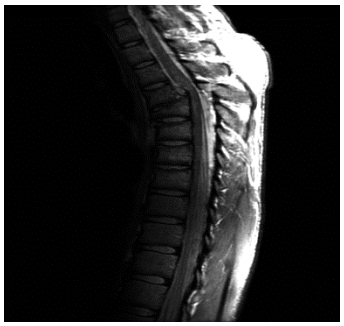
<td rowspan="3"> 
Fractured_spine image [20]</td>
<td>Fractured_spine image When gamma=2 in power-law
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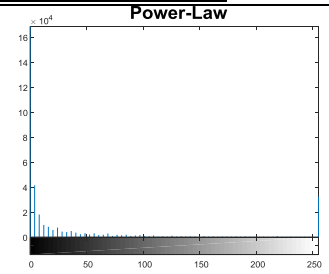
<td> 
histogram of Fractured_spine image When gamma=2 in power- law</td>
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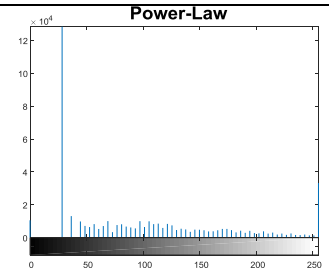
<td> 
histogram of Fractured_spine image When gamma=0.4in power- law</td>
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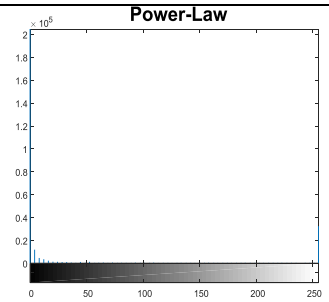
<td> 
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<td>Piecewise – linear transformation</td>
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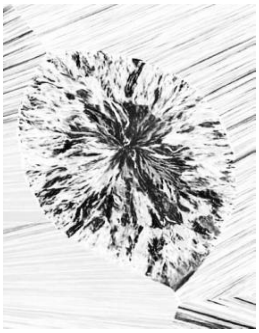
<td> 
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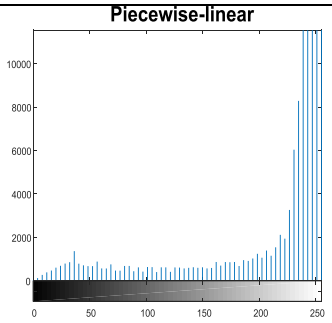
<td> 
Histogram of Cholesterol image in human body
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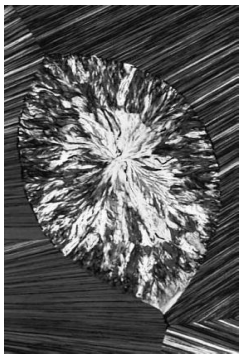
<td rowspan="2"> 
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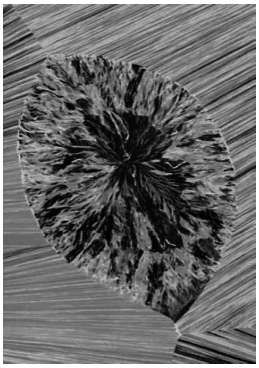
<td> 
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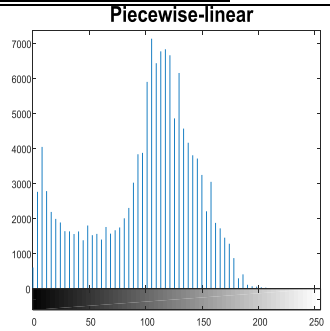
<td> 
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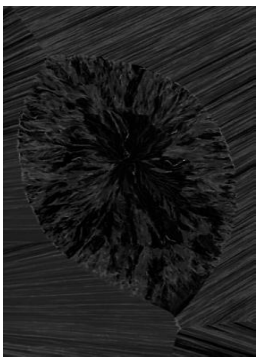
<td> 
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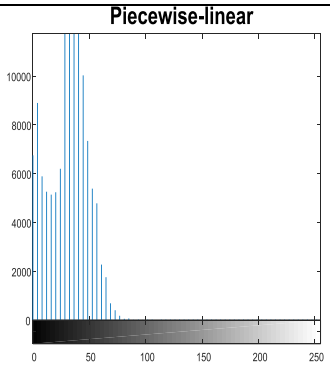
<td> 
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With low contrast</td>
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<td>Histogram processing</td>
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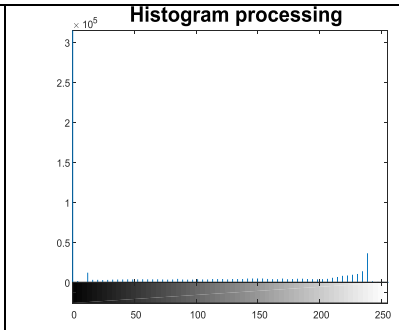
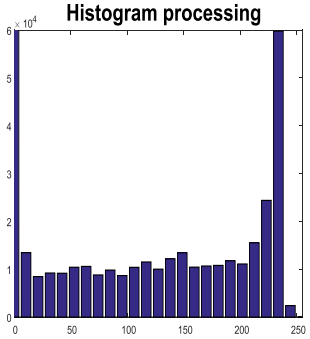
<td> 
Histogram of skull image</td>
<td> 
Bar graph of Skull image</td>
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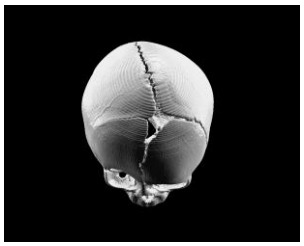
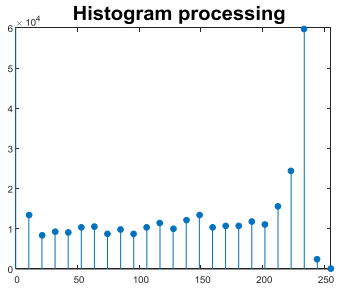
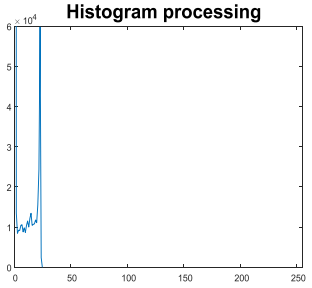
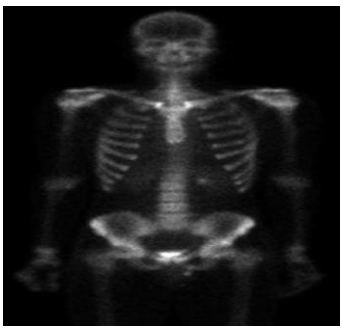
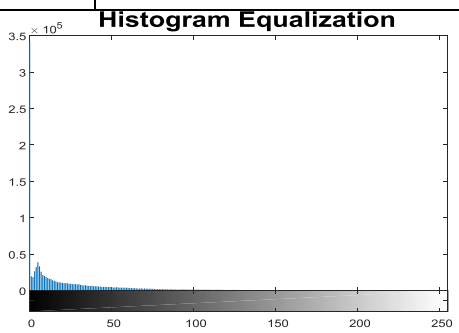
<tr><td></td><td> 
Skull image of human[20]</td><td> 

Stem graph of skull image</td><td> 

Plot graph of skull image</td></tr>
<tr><td>Histogram Equalization</td><td> 
Partial body scan image before histogram Equalization [20]</td><td colspan="2"> 

Before histogram Equalization of Partial body</td></tr>
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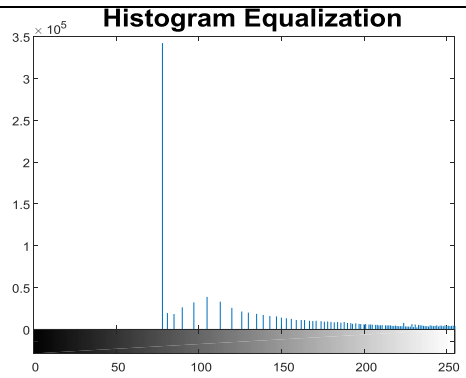
Partial body scan image After histogram Equalization</td><td colspan="2"> 

After histogram Equalization of Partial body</td></tr>
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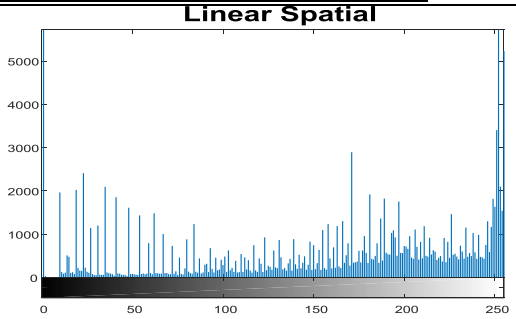
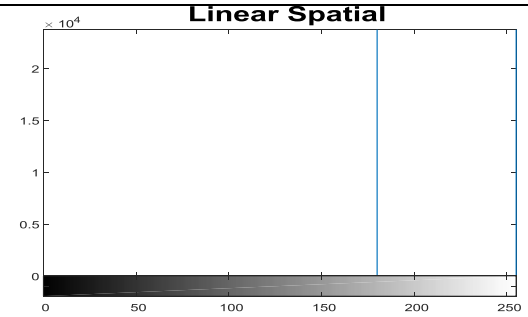
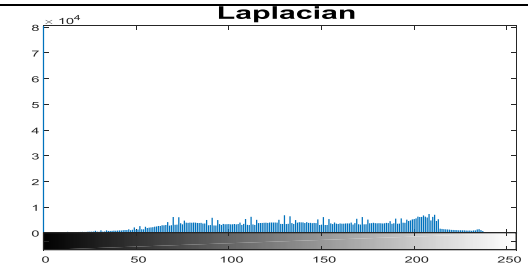
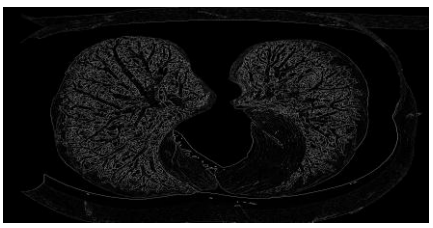
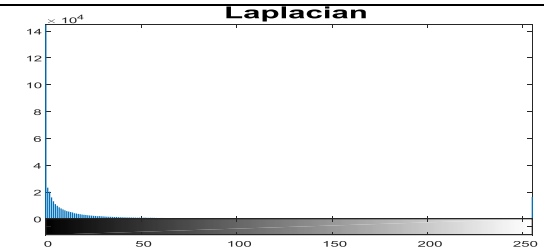
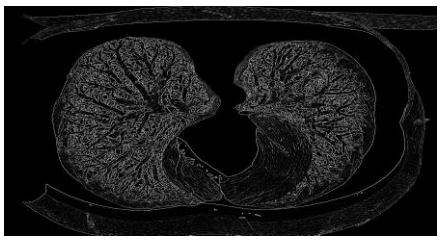
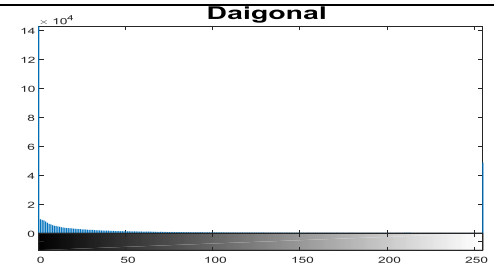
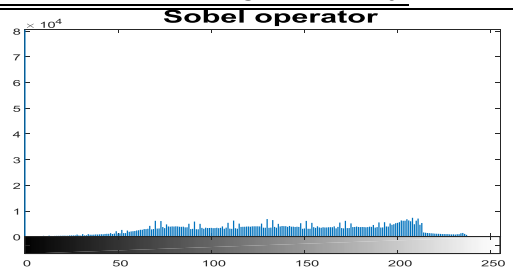
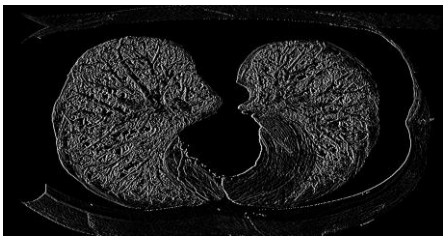
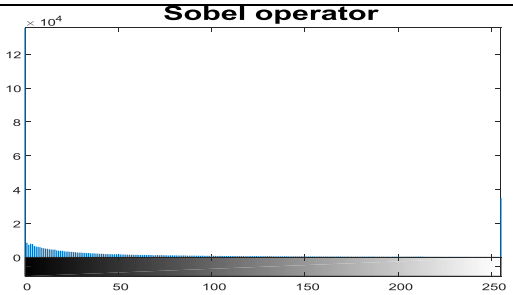
Linear spatial filtering	 MRI-of-Knee image before linear spatial filtering [20]	 Histogram of MRI-of-Knee image before linear spatial filtering
	 MRI-of-Knee image after linear spatial filtering	 Histogram of MRI-of-Knee image after linear spatial filtering
Laplacian filter	 Lung image of human before Laplacian filter[20]	 Histogram of Lung before Laplacian filter
	 Lung image of human after Laplacian filter	 Histogram of Lung after Laplacian filter
Diagonal filter	 Lung image of human after Diagonal filter	 Histogram of Lung after Diagonal filter

Sobel operator	 Lung image of human before Sobel operator	 Histogram of Lung before Sobel operator
	 Lung image of human after Sobel operator	 Histogram of Lung after Sobel operator