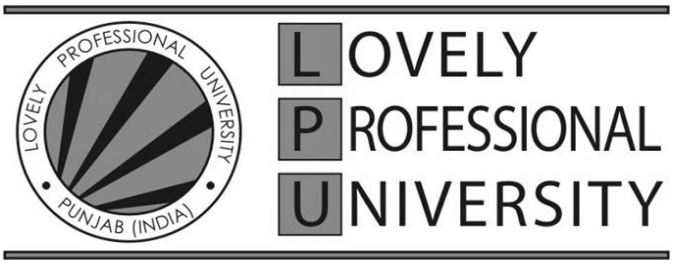

X-Ray Image enhancement and Detection of Tuberculosis

DISSERTATION

Submitted in partial fulfillment of the

Requirement for the award of the

Degree of

MASTER OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

Sachin Choudhary

Under the Guidance of

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(Assistant Professor)

School of Electronics & Communication Engineering

Lovely Professional University

Punjab

(MAY 2015)

CERTIFICATE

This is to certify that the Dissertation titled **"X-Ray Image enhancement and detection of tuberculosis"** that is being submitted by "***Sachin Choudhary***" is in partial fulfilment of the requirements for the award of MASTER OF TECHNOLOGY DEGREE, is a record of bonafide work done under my guidance. The contents of this Dissertation-II, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified

GAURAV SETHI

Assistant Professor, SECE

(Lovely Professional University)

Objective of the Dissertation is satisfactory / unsatisfactory

Examiner I **Examiner II**

ACKNOWLEDGEMENT

I like to take this opportunity to express my deepest gratitude to my valuable guide **Mr. GAURAV SETHI,** Assistant Professor, School of Electronics & Engineering (SECE), Lovely Professional University**,** for discussions we had while I was working on my dissertation.

I would like to express my gratitude towards **Assistant Professor Nikesh Bajaj, SECE, LPU** for his worthwhile suggestions ever willing and fruitful guidance and also for all knowledge they imparted to me during the course of time.

This would not have been possible without the generous M.Tech studentship from Lovely Professional University, which I gratefully acknowledge. I would like to thank GOD, the almighty who has been too merciful and compassionate, for his blessings which have enabled me to pen this work.

I would like to thank my parents and friends for their encouragement and faith in me while I was working on my dissertation. I can never forget my parents whose boundless love, sacrifice, constant inspiration, emotional support and encouragement & blessings brought me where I am today. My parents' unending shower of blessing kept me moving easily with all hazards vanishing miraculously.

Sachin choudhary

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CERTIFICATE

This is to certify that **Sachin choudhary** bearing Registration no. **11311382** has completed objective formulation of Dissertation titled, "**X-ray image enhancement and detection of tuberculosis"** under my guidance and supervision to the best of my knowledge, the present work is the result of her original investigation and study. No part of the Dissertation-II has ever been submitted for any other degree at any University. The Dissertation is fit for submission and the partial fulfilment of the conditions for the award of the Degree of Master of Technology (Electronics & Communication Engineering).

Mr. Gaurav Sethi

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DECLARATION

I, **Sachin Choudhary**, student of Master of Technology in Electronics & Communication Engineering under Department of Lovely School of Electronics & Engineering of Lovely Professional University, Punjab, hereby declare that all the information furnished in this Dissertation report is based on my own intensive research and is genuine.

This Dissertation does not, to the best of my knowledge, contain part of my work which has been submitted for the award of my degree either of this university or any other university without proper citation.

Sachin choudhary

Date: **Reg.no.11311382**

ABSTRACT

As the digital images widely used in the many application with the increasing popularity and the availability of low cost image editing software the integrity of digital image content can no longer to be taken for granted. In the medical field the images from x-ray, ct scan, ultrasound and magnetic resonance imaging systems helps doctor to look at the inner part of the body easily. But many times the image from these systems is affected due to noise, blurred and sometimes the important information cannot visible. Due to this it is difficult to get the detail from these images. Some of the standard image enhancement method such as spatial domain enhancement and frequency domain enhancement techniques we used. In some cases detection of abnormalities from the part of the body is also important with enhancement. Thus in this dissertation method for enhancement of the image with the detection of tuberculosis is purposed so that maximum information can be retrieve. A new algorithm is applied for enhancement of image for the better quality. In this algorithm we detect the tuberculosis with the help of log Gabor filter and then enhance with the basic technique histogram equalization technique. After enhancement the result of detection is increases.

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CHAPTER 1

INTRODUCTION

1.1 Image

An image is a matrix or array consisting of square pixel arranged in columns and rows. Image is said to be digital if it represents a finite set of digital values called pixel or picture element and represents in two dimensions. These images are used because digital data do not change when even it is reproduced a number of times and also it retain the originality of data pixel values represent gray level colors heights opacities etc.

1.1.1 Common formats of image:

1. 1 sample per point (B&W or Grayscale)
2. 3 samples per point (Red, Green, and Blue)
3. 4 samples per point (Red, Green, Blue, and "Alpha", also known as Opacity)

Gray scale images are mostly used in the processing because in the gray scale the intensity of every pixel is from 0-255. Normally the gray scale images are called as the black and white image includes many shades of gray color.

The range of the pixel value depends on the depth of color of the image, the gray scale image have 8 bit color depth= 256 gray scales. Basic color images have 24 bit color depth=8*8*8=256*256*256. It means that the true color have 16 millions of colors approximately.

1.1.2 Common image file formats:

1. **GIF**: This is a non-destructive 8 bit, compressed bitmap image format. This format is mostly used for web. The animated GIF is one of the sub-standards of the GIF.
2. **JPEG**: This format of image contains much information as per byte. The JPEG format of the image is more efficient than other format. It is 24 bit highly compressed (16 million colors) bitmap format. This is band limited format and used for web and internet.

3. **TIFF**: This format also a bitmap format having 24-bit publication. Non-destructively compressed with Lempel-ziv-Welch compression. This format is also used in the web.
4. **PS (Postscript)**: This format is the standard vector format. This format have number of sub-standards but difficult to transport from one platform to another and for operating
5. **PSD**: This format dedicated to photo shop it keeps all information in image including all layers.

1.2 IMAGE PROCESSING

The processing of image is basically method to convert an image into digital form and perform some operation whether it is enhancement an image or extracting features or information from an image also segmented the abnormal part. Examples of computerized methods for information extraction is pattern recognition, classification etc. from remotely sensed image to obtain categories of information about a particular feature. It is the type of signal dispensation in which the input signal is image and output may be image or characteristics related to the input image. Usually image processing system includes treating images as two dimensional signals. Now a days it has become the most rapidly growing technology with its applications in almost every field such as Biology, Astronomy, Medicine, Security, Biometrics, Satellite imagery and many more. It includes Image display and printing, Image editing and manipulation, Image enhancement, Feature detection, Image compression etc. Few examples of image processing are Noise removal, Contrast adjustment, Edge detection, Region detection and segmentation, Image compression etc[12].

Processing on image includes the following steps:

1. Capture the image with scanner or by a camera.
2. Image pixels are changed accordingly and analyze i.e. image enhancement and compression and spotting the patterns that are not recognizable to human eyes
3. At the end Output is the altered image or report that is based on image analysis.

1.2.1 Fundamental Steps of Image Processing:

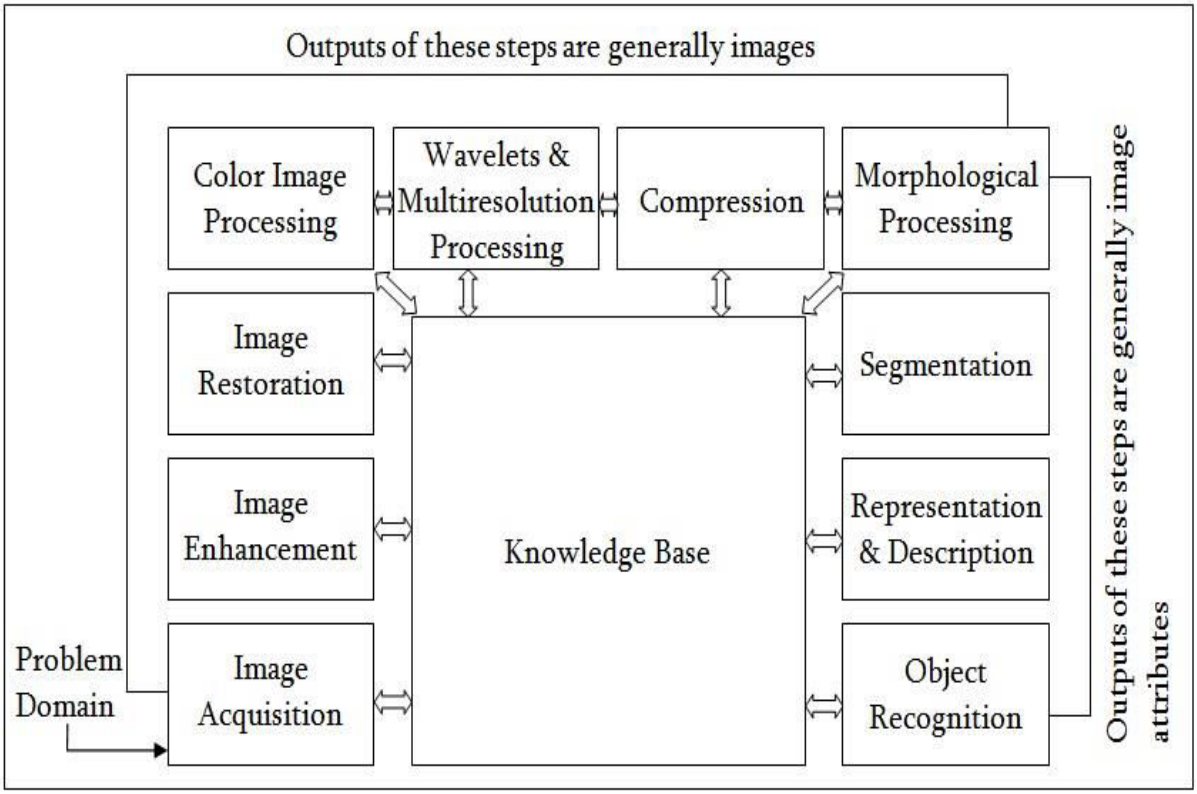


Figure 1.1 Fundamental steps of image processing

1. Image acquisition

The image acquisition is the very first process in the image processing. Depends on the source, the illumination is reflected from objects. In some of the application the reflected light is incident on photo converter which converts the energy into the visible light called image.

2. Image Enhancement

Enhancement of image is the very important and simple area in image processing. The enhancement is done for extract or brings out important detail from the digital image, or simply to highlighted important features of our interest in that image. A very simple example of the image enhancement is to contrast enhancement in which we increase the contrast of the image so that it may look good.

3. Image restoration

Image restoration deal with improves the appearance of an image. Unlike the image enhancement that is subjective approach the restoration is subjective. In the other sense restoration techniques are based on mathematical model of image degradation.

4. Color image processing

It is an area of image processing deals with the different concepts of colour models. There are many colour models in the colour image processing RGB, HIS etc.

5. Wavelets and multiresolution analysis

These are the multiresolution technique it is the foundation for representing image in various degree of resolution.

6. Compression

The image compression is used to reduce the storage required to save the image. There are various image compression techniques example DWT, Huffman coding etc.

7. Morphological processing

It deals with tools for extracting the components of image that have useful representation and description of shape.

8. Segmentation

It deals with the portioning the image into the certain parts or objects. There is several methods in which the segmentation deals to detect the edges, point lines. It is the process of dividing of an image into its parts or objects. The task of segmenting the image is one of the most difficult tasks in digital image processing. However, the more accurate is the segmentation process, the more likely recognition can be done.

9. Representation and Description

After segmentation, we get the raw pixel data that represents only the boundaries of regions or the every pixel contained in that region. In both the cases, conversion of data is needed for further processing on it. It is necessary when we are to focus on internal details or features of any particular region. Description includes the selection of the procedure.

10. Object Recognition

Assigning a label to the objects on the basis of information provided by the descriptors. Image recognition is also one of the important tasks since it includes recognition of regions also called objects or patterns.[12]

1.2.2 Image processing application

Intelligent transport system: This technique is used to recognition of traffic sign and automatic recognition of number plate.

Remote Sensing: For this application, images of earth surface captured by sensors by satellites or spectral scanners on the aircrafts are processed after transmitting to the earth. These images are used to detect regions sand objects by various image processing techniques such as resource mobilization, monitoring, city planning etc.

Defense surveillance: Surveillance methods are used through aerials to watch the land and oceans. This application is also used to locate anything on the ocean surface. It also recognizes the objects distribution in different direction.

Biomedical Imaging techniques: This is most important application in image processing field. There are many types of imaging tools as x-ray, ultrasound, CT scan, computer aided tomography used for medical diagnosis.

Automatic Visual Inspection System: This is most important application for the industries that improve the quality and productivity of the products. Example: in a bulb manufacturing company, detection of defected filaments is done with image processing instead of manual inspection that saves time and other resources at a low cost and with higher accuracy.

1.3 IMAGE ENHANCEMENT

The main objective of enhancement is to processing an image so we present the good quality of image for any specific application. Depends on the objective that we want to achieved we apply the enhancement algorithm as well as the application. Example, For example for the x-ray image enhancement algorithm is not best approach to enhance image of microscopic

images. The image enhancement is one of the most interesting techniques of image processing.

The image enhancement can do in two domains: one is the frequency domain other is the spatial domain. In Spatial domain the direct manipulation of pixel is done and it includes the image plane, direct manipulation of pixels is done in an image. In frequency domain images are processed by modifying the Fourier transform. After processing the original image the judgment depends on the viewer how well the method is working. Quality of image and its visual evaluation is completely subjective. Since an image is called a good image if it satisfies the fixed standard for evaluation after applying any algorithm. Processing of the images for machine input is somewhat easier. Example: character recognition through image processing.

1.3.1 Spatial domain enhancement techniques

In the spatial domain enhancement techniques deals with Gray level transformations: The gray-level transformation is the simpler image enhancement technique. The values of the pixels before and after enhancement are denoted with the r and s. These values are comes from the expression i.e. rTs (T is the transformation function here that maps the value of r into the pixel value s). The basic function that are used for image enhancement:

1. Negative and identity transformation(Linear transformation)
2. Log and inverse log transformation(Logarithmic transformation)
3. Nth power and nth root transformation(power-law)

1.3.1.1 LINEAR (negative transform and identity transform): The image negative of an gray level is in the range$[L-1,0]$, this is find by the negative transformation given by the expression and shown

$$s = L - 1 - r$$

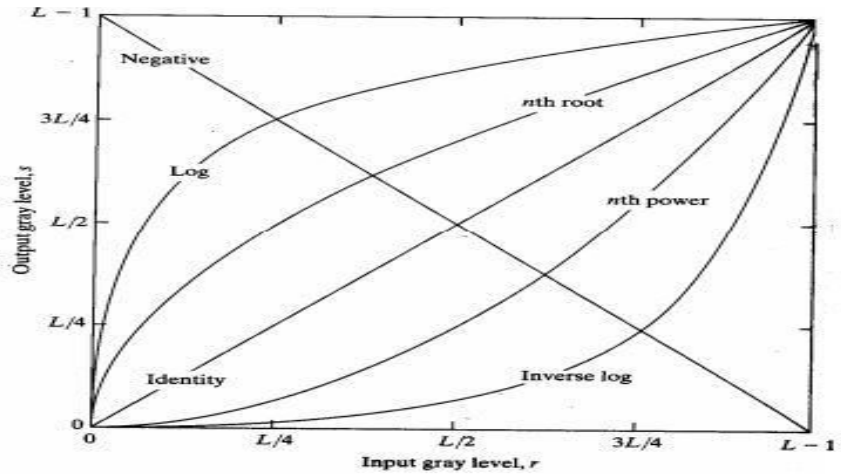


Figure 1.2 Basic gray level transformations

This formula reverses intensity levels of an image to produce the equivalent of a negative photograph. This technique is used for enhancement gray or white detail in dark regions of the image.

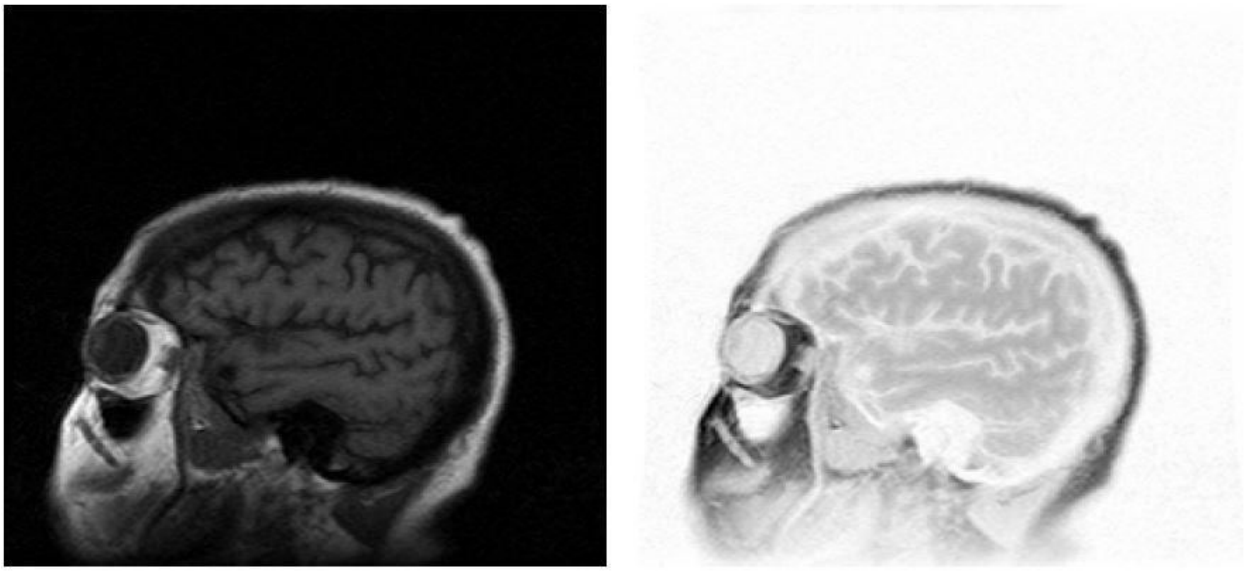


Figure 1.3 Image and its negative

1.3.1.2 LOGARITHMIC (log and inverse-log transformation)

The basic form of a log transformation is

$$s = clog(1 + r)$$

c is constant here and it is assumed that $r \geq 0$. It maps a low gray level of value into wider range of level, and this is opposite is for higher values of pixels. The dark pixel of the image is expended in this transformation while the compression the higher level of values; the reverse operation is true of inverse transformation. The curve with the shape of log function spreading of gray levels in the image. This function compresses the large variation in pixel intensities. The explanation of this application in which the pixels values have a large variations and dynamic range is the Fourier spectrum. They may encounters spectrum values ranges from 0 to 10. The wide range of intensity values cannot reproduce by the image display system. In the typical Fourier spectrum the effect of significant detail will be lost.

1.3.1.3Power law transformation

Power law transform is the form of

$$S = cr^{\gamma} \text{ or } s = c(r + \varepsilon)^{\gamma}$$

Where $\boldsymbol{\gamma}$ and c are the constant. For the different value of g the plot of s versus r in fig. As like log transformation the power law curves fractional $\boldsymbol{\gamma}$ maps narrow range of dark values into wider range of output and reverse action for the higher value. In this we have family of possible transformation curves for different value of $\boldsymbol{\gamma}$. See the curve generated for values if $\boldsymbol{\gamma}$ >1 have reverse result as compared to those generated with the values of $\boldsymbol{\gamma}$<1.Multiple devices used power law transformation to capture, print and display the images.

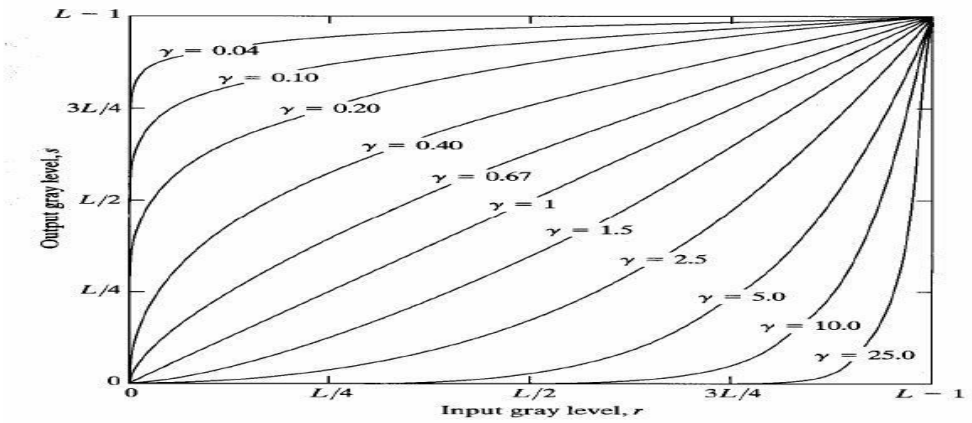


Figure 1.1 Power law transformation

For displaying image accurately on monitor the Gamma correction is important. Images that are look bleached or darker. To accurately reproduce the color also the knowledge of gamma correction is requires because it not changes only the brightness but also ratio of R-G-B. Due to gamma correction the use of digital image in the internet has increased. Now some of the computer even has built in partial gamma correction.

With gamma correction the power law transformation is also useful for contrast manipulation. Example the MRI image of head the image is dark and for this the gray level expansion is necessary. This can be completed with the power-law transformation with fractional exponent as:

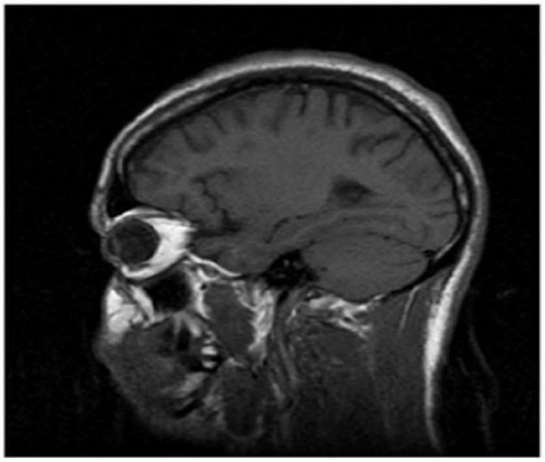


Figure 1.5 MRI of Head

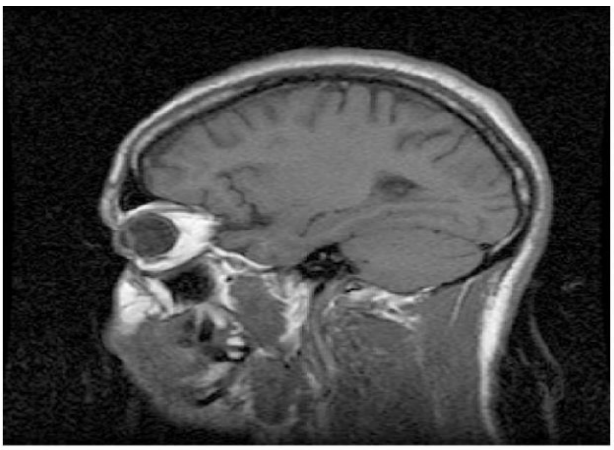


Figure 1.6 Result of Apply transformation

c=1 $\boldsymbol{\gamma}$=0.6

Figure 1.7 Result of Apply transformation c=1 γ=0.4

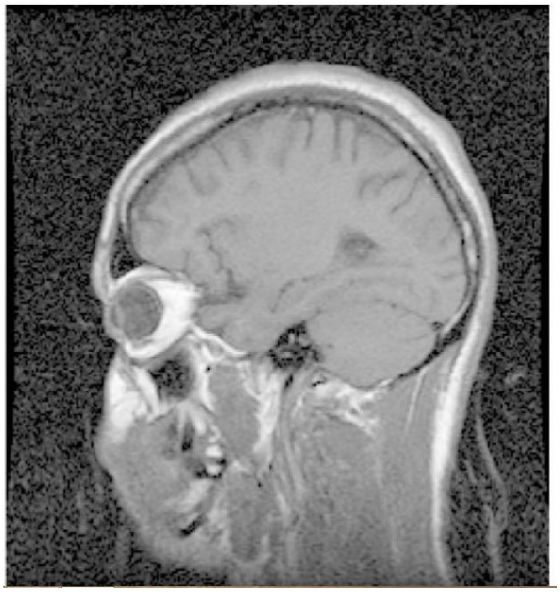


Figure 1. 8 Result of Apply transformation c=1 and $\gamma = 0.3$

The figure shown are obtained by the applying the power law transformation function. The values of g for images are 0.3, 0.6 and 0.34 respectively and the value of c is same for all images obtained by processing Figure with the power-law transformation function. In the results we notice that as we go with decreased in value from 0.6 to 0.4 more detail of image become visible. As we further decreases the value 0.3 it enhanced more information in the background. At the end when we compared all the result we see that the best results of the enhancement and detailed was obtained from the 0.4. The value of g is 0.3is a below the limit from which the contrast would reduce to an unacceptable level.

1.3.2 Histogram processing

Histogram of the image with gray level $[0, L-1]$ is a digital function h (r_k) = n_k. Here r_k is the kth gray level and n_k is no of pixel having gray level r_k. Histogram normalization is done by dividing each value of pixel with the total number of pixels present in the image denoted by n. The normalize histogram is produced by $P(r_k)=n_k/n$, for k=1,2,……..L-1,where $P(r_k)$ is estimate of probabilities of occurrence of gray level.

Histogram is the basis fundamental for the numerical spatial domain techniques. The calculations of Histogram are used for the enhancement of image. The information from the histogram of image not only gives the useful statistic but this information is also useful in another processing application such as image compression and image segmentation. Histogram can we find with the help of software and implement in the hardware. Here consider the four basic types of image: light dark low-contrast high contrast and the histogram of the image as shown in figures.

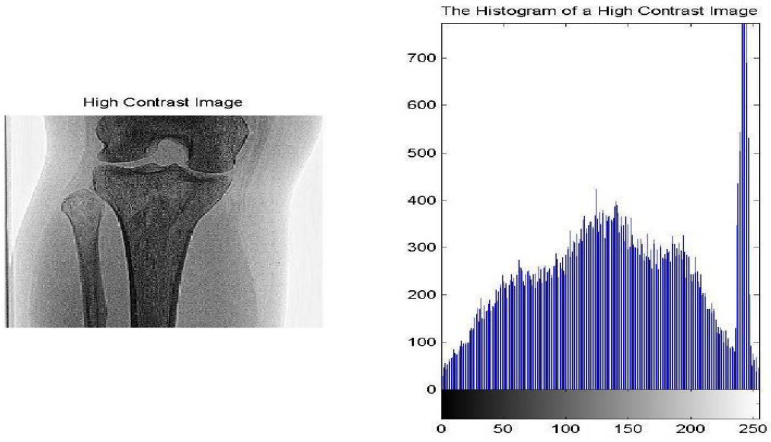


Figure 1.9 High Contrast Images and their Histogram

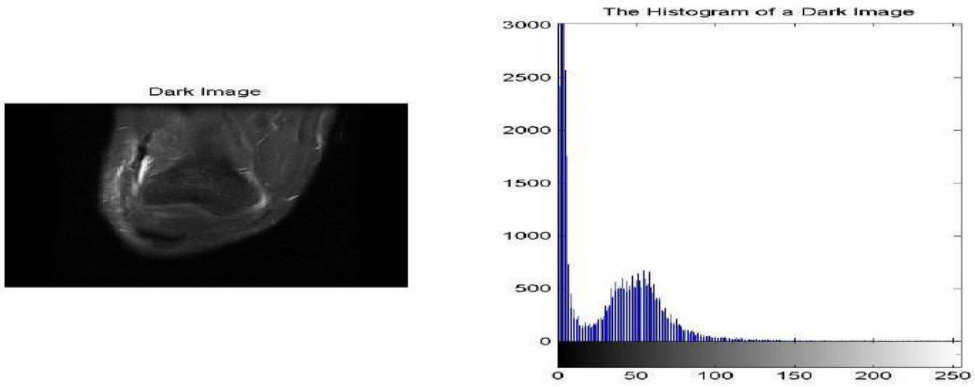


Figure 1.10 Dark Images and Their Histogram

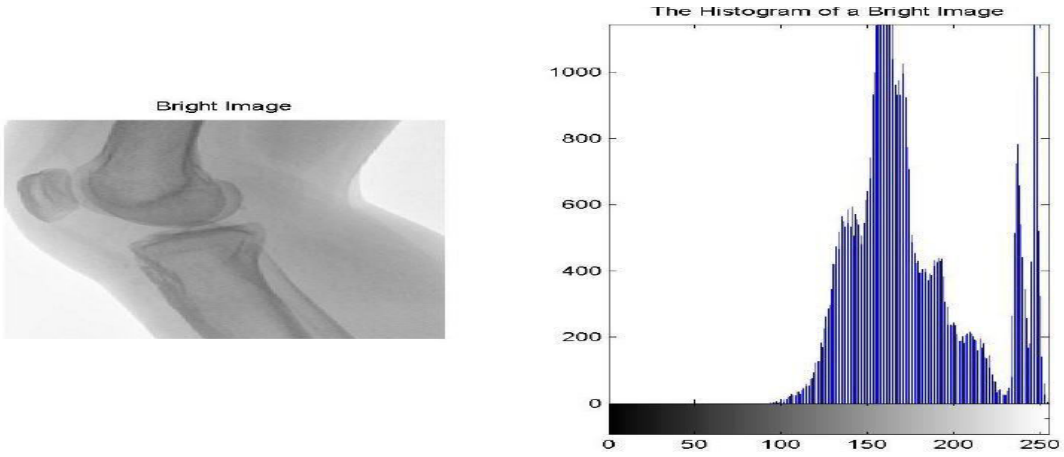


Figure 1.11 Bright images and their histogram

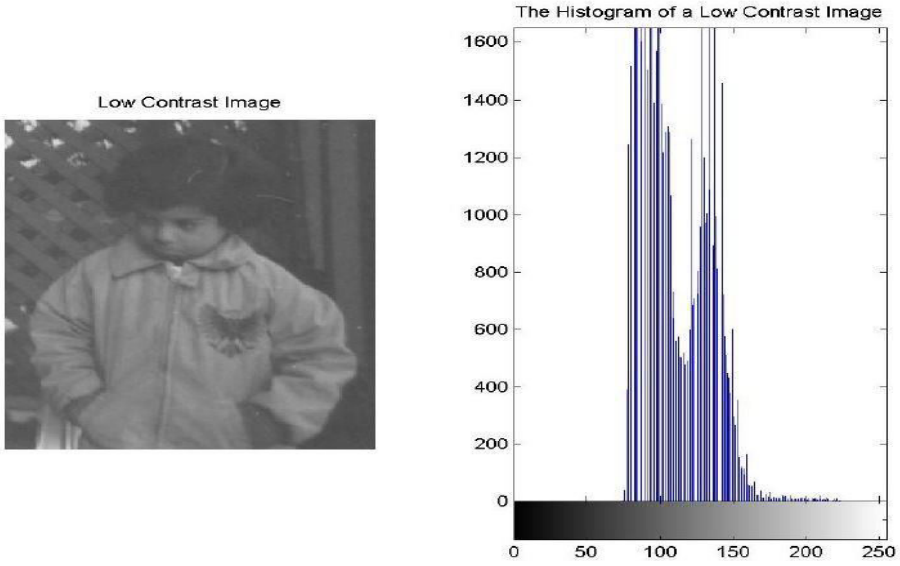


Figure1.12 Low Contrast Image and their Histogram

The vertical axis of the histogram plot shows value of the $P(r_k)=n_k/n$ if the values are normalized. The horizontal axis of histogram tells the value of gray. For the high contrast image the histogram component cover a broad range of the gray scale and its distribution of pixels is very close to uniform there is very few vertical lines are higher than other. In the dark image the component of the histogram are towards the lower part of gray scale. The component of histogram of the bright image are concentrate towards the higher part of the gray scale and components, the histogram of low contrast image is concentrate towards the middle of the image. There are two techniques under the histogram processing that are

histogram equalization and histograms matching these both are used for the enhancement of the image.

The histogram equalization is the transform that produces an image with a uniform histogram. This method is good because the results are predicted and this method is simple to implement. In some of the application where the image enhancement with the histogram equalization is not desired . In sometimes it is better to specified a histogram of the image. For obtaining the image with the specified histogram we used the histogram matching techniques.[12]

1.4 Spatial Domain Filtering

These filters are Smoothing filters. They are mainly used for noise reduction and blurring. Blurring is used in preprocessing tasks at the initial state; to remove the small noise also the small detail from the image, filtering also used to join the gaps in lines or curves. Noise is removed by linear and non linear filters. We can use different kinds of spatial filters to remove the different types of noise, some of these filters are:

1. Geometric mean filter
2. Harmonic mean filter
3. Contra harmonic mean filter

Some of Spatial domain filters that based on the order of the pixels that are:

1. Median filter
2. Max and min filter
3. Midpoint filter
4. Alpha trimmed mean filter

1.5 Frequency Domain

Biomedical image enhancement techniques use wavelets. The main motive of the enhancement is to process an image so that it has better presentation than the original image for a specific application. The algorithm of enhancement based on the objective that we want to achieved and also the application for which the technique in used. Example the enhancement algorithm used for x-ray image may not be good for the enhancement of microscopic image. The image enhancement is most interesting area in the image processing field.

The enhancement can we classified in two domain spatial domain and frequency domain as we discuss above the spatial domain techniques are apply in image plane. But in case of frequency domain direct manipulation of pixels is done. In this domain the techniques are depends on modifying the Fourier transform for example stft, dct and wavelets.

There is no known general theory of image enhancement. When an image is processed for visual interpretation, the viewer is the ultimate judge of how well a method works. The visual evaluation of image quality is highly subjective. The definition of a "good image" becomes an elusive standard used to evaluate algorithm performance. When the problem is the processing images for machine perception, this evaluation task is somewhat easier. For example, in a character recognition application, and not considering other issues such as computational requirements, the best image processing method would be the one that yields the best machine recognition results. However, even in situations when a clear criterion of performance can be imposed on the problem, a certain amount of trial and error usually is required before any image enhancement approach is selected

Wavelet Analysis

The theory of wavelets is the results of a multi-disciplinary effort that was done together by the engineers, mathematicians and physicists. This connection was gives flow of ideas that goes well beyond the construction of new bases or transform.

The past decade has witnessed of the development of wavelet analysis, a new tool which comes from mathematics and was quickly adopted by the fields in engineering and science. After the certain period its creation, it has reached a certain level of maturity as well as well

Defined mathematical discipline, with its own conferences, journals, research monograph and textbooks. Wavelet analysis has wide number of applications such as signal processing, compression of data in image solving, partial differential equation, handling Multiscale process and statistics. There seem to be no limits to the subjects they can be applied. Fundamental ideas often appear at about the same time to many researchers in widely separated disciplines. The ideas behind wavelet analysis constitute an example. Most fundamental and scientific concepts also have antecedents that helped to discover the ultimately successful approach. Wavelet analysis has a rich collection of precedents that were interesting but narrowly focused; these probably helped to the researcher to find the class of the problems that can takes the benefit from the wavelet analysis. Although the Fourier transform has very much effect on the transform based processing of the image since the late 1950s, the wavelet transform is making easier the compression, transmission and analysis of image. The sinusoids are the basic function for the Fourier transform. The wavelet is basically a sliding window. It based on the small waves of limited duration which have varying frequencies. The wavelets tell about which frequency is present at what time whereas the Fourier transform tell only about the frequency information time information is not remain in the transformation process.

1.5.1 Log Gabor wavelets

In the image processing the log Gabor filters are widely used. The kernels of these wavelets have many properties. These properties of wavelet kernels made selectively spatial frequency characterization and localization which means that these filter have best simultaneous frequency localization and have information in spatial plane. These filters are very successful but only have a one limitation that is the bandwidth limitation. To overcome these problem have to maintain maximum spatial localization and obtained maximum spatial information. For this a new filter is introduced called log Gabor filter[14]. These filters give response that is Gaussian when the logarithmic frequency scale is viewed instead of linear one. These are constructed with arbitrary bandwidth this bandwidth is made to produce minimal spatial extant filter. The Log-Gabor filter is :-

$$G(w)=e^{-\left[\log\left(\frac{w}{w0}\right)\right]^2}/2[\log\left(\frac{w}{w0}\right)]^2$$

w_0 is the centre frequency of the filter. The transfer functions of the log Gabor function is shown in fig.

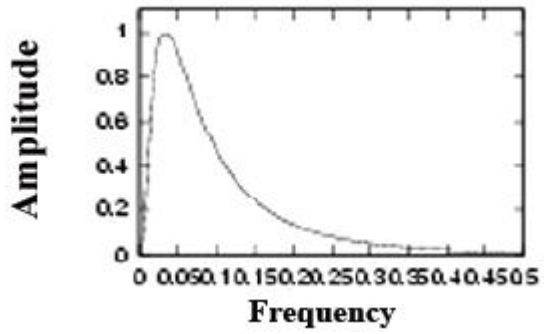


Figure1.13 Transfer function of loggabor filter

There are two important features of log Gabor filter function

1. No DC component are present
2. At high frequency have an extended tail.

The features (1) enables the design of filters in quadrature pairs whereas the transfer function of Gabor filters of the sum of two Gaussians centered at minus and plus the centre frequency this results in nonzero DC component.[15] Feature (1) is the important features of the filters. When log Gabor filters have extended tails on the high frequencies are able to encode natural image more efficiently than Gabor function which suppress higher frequency component and thus image detail.

1.6 Morphological Transform

The morphological operations are used to obtain the shape of image. It performs an important role in the image processing. The morphological transform is also called the mathematical transform. There are four operations in the morphological transform i.e. opening and closing, erosion and dilation. Among of all these dilation and erosion is most important operator to obtain the point. The dilation expands the shape of the point (pixel) of the image and erosion shrinks the shape of image.

Dilation: - The dilation operation is denoted by X⊕B and defined as:-

$$\boldsymbol{X \oplus B = X + b = \{x + b : X \& b \epsilon B\}}$$

X is the gray scale image B is the structuring element. The output of the dilation is set of translated points. The translation of structuring element has non empty intersection with the gray scale image. The dilation of X by the factor B is the set of the all displacement. Such that x and b overlap by the at least one structuring element. The bridging of gap is simplest application of the dilation operation. The gap is repaired with the help of the structuring element.

Erosion:-Both the erosion process is the same as the dilation; in dilation it shrinks the point i.e. we turn the pixel to 'white, not black'. The erosion operation is denoted by X⊖B and is defined as:

$$X \ominus B = X - b = \{z : (B + z) \subseteq X$$

In the above equation X is gray scale image and B is the structuring element. The translated structuring elements contained in the input image set X and the erosion is the set of translation point. In above equation the erosion of gray scale image X by the structuring element B. B is the set of all point b. The simplest example of the erosion is used for eliminating the unnecessary detail from the gray scale image.

1.7 Organization of Dissertation

Chapter1- Includes the introduction of image, image processing and different techniques of enhancement

Chapter2-Includes the literature review on image enhancement and also detection which helps to find the platform for future work

Chapter 3-This chapter based on the problem formulation, objective and methodology

Chapter 4-This chapter includes the results and discussion.

Chapter5-This chapter based on the conclusion and future scope of the study.

CHAPTER 2

REVIEW OF LITERATURE

Lei WANG, Nian-de Jiang, Xing Ning(2012) Gave the enhancement algorithm depends on the mixture model of Gaussian scale for the coefficient of wavelet in Multiscale analysis. The images that are affected by noise are denoised in auto adaptive filter. The wavelet coefficients are goes through the classification and qualitative analysis for noise and signal. The approximation distribution and statistical characteristics of the wavelet are described. In this paper there is a combination of GSM model for wavelet coefficient. It is clear that this algorithm improves the enhancement and de-noised results.

Conclusion: The method for image enhancement is proposed here is depends on GSM model of wavelets coefficients. A model for the signal and noise is analyzed with the quantitative analysis and classification of the wavelet and relationship between domains layers of wavelet transform is used, and then the correlations between those wavelet coefficients are studied. The result shows that this method not just enhanced the image but also detailed the characteristics of the image.[1]

Deepak Prasanna.R, Neelamegam.P, Sriram.S, Nagarajan Raju(2012) When the hand image is captured it needs to be good enhancement technique for the detection of the vein patterns. Sometimes there is false detection of veins this is due to the presence of unwanted noise and different state of hand image. For the better perception of human and making further processing easier it is necessary to improve the image with the help of enhancement technique. To improve the image for better perception of image they explain various method of enhancement and make further processing easier. There are various enhancement techniques are explain in this such as image negative, gray level slicing, high boost filter and equalization of histogram. These methods for enhancement are applied to image of hand using open source computer vision library. At last the best technique is found the histogram equalization is the best technique from all these.[2]

Ali Zifan, Mohammad Hassan, Moradi Shahriar, Gharibzadeh(2013) Gave an idea that used in the microarray image processing procedure and deal with the noise properties. In this they used the decimated and undecimated multiwavelet having denoising capability, both

decimated multiwavelet transform and undecimated multiwavelet transform used in microarray images to remove the noise. At starting the initialization provides sparse representation of signal then the transform so that the difference of signal and noise is clearly found. In image denoising in order to capture the salient wavelet transform the redundancy of undecimated multiwavelet transform is useful. And denoted with the SWT and DWT. The quality of the enhanced image using the proposed approach especially in undecimated case is good as compared to the DWT and wiener filter[3]

R. Tappenden, J. Hegarty, R. Broughton, A. Butler, I. Coope, P. Renaud(2013), Previous work has investigated the feasibility of using Eigen image-based enhancement tools to highlight abnormalities on chest X-rays . While promising, this approach has been limited by computational restrictions of standard clinical workstations, and uncertainty regarding what constitutes an adequate sample size. This paper suggests an alternative mathematical model to the above referenced singular value decomposition method, which can significantly reduce both the required sample size and the time needed to perform analysis. Using this approach images can be efficiently separated into normal and abnormal parts, with the potential for rapid highlighting of pathology.

Conclusion: The determinant based feature selection method described is a novel approach to the enhancement of chest radiographs. Compared to previous work it uses a more efficient mathematical process and requires fewer normal images through its facility to define an adequate sample size. The approach results in reduced computer processing time, and its ability to recognize limits of variance would allow it to be calibrated against a local PACS archive data set. The process is efficient enough to be employed in standard clinical scenarios without delay to the referrer and could potentially be integrated in standard point-of-care systems without additional equipment. While the examples provided in this article show that this approach is successful at highlighting abnormality on chest X-rays, it is relevant to observe that the clinical utility of this approach is not yet known. While it is hypothesized that this would be of benefit by highlighting abnormality to the non-radiologist reviewer, further study is required to assess if any significant improvement in clinical management results from the implementation of this method.[4]

Jihoon Park, Jin Bum Kang, Jin Ho Chang and Yangmo Yoo(2014) The various techniques for speckle reduction as frequency compounding (SR-FC), as spatial compounding(SRSC),and post filtering(SR-PF),post filtering, spatial compounding(SRSC) have been proposed. In SFRC the uncorrelated sub-image which are obtained by dividing the spectrum of radio-frequency signal on reception or by varying the center frequency on transmission. Are compounded to lower speckle, the sub-images in SR-SC are getting at different beam orientation at the expense of temporal resolution. On the other hand, in SR_PF compounding multiple sub-images, a specially designed spatial filter, e.g. Laplacian pyramid based nonlinear diffusion is applied to a single image. These techniques can join together to maximize the effect of speckle reduction. This review briefly introduced the principle behind three speckle reduction techniques and describes their own strengths and weaknesses. Finally, some clinical examples of speckle reduction techniques are presented.

Conclusion: It is important to reduction of effective speckle for improving image qualities e.g. contrast resolution and to understand the image e.g. image segmentation and registration in medical ultrasound imagine. Three classes of speckle reduction techniques i.e. SR-FC, SR-SC and SR-PF, have been widely used for alleviating the effect of speckle while preserving the edge and boundaries and edge of structures in modern ultrasound imaging system. For increase their performance the three speckle reduction techniques can be combined together. However, the optimization of the many parameters in the speckle reduction techniques must be carefully conducted by considering the characteristics of the input image and clinical setting[5]

Wavelet versus Laplacian Pyramid (2007) Speckle in other words called as the random multiplicative noise. The perception and the extraction of fine detail of the image is affected by this speckles. This multiplicative noise can be removed. The reduction techniques are applied to reduce the effect of noise from the ultrasound image to improve the visual quality and also for the better diagnosis. It is also used as preliminary treatment before segmentation and classification. Several methods have been proposed for speckle reduction in ultrasound images. Multiscale contrast enhancement has proven to be very efficient for x-ray images. A recent study by Dippel et al. doing a comparison, contrast enhancement of radiographs (x-ray and mammography), between the Laplacian pyramid and the wavelet one proves that the

Laplacian pyramid method gives a better result than the wavelet one; the filtering aspect was not taken into account. In ultrasound images a strong contrast variation exists which is different from x-ray and mammography. In this paper a wavelet pyramid with simultaneous speckle reduction and contrast enhancement was applied for the first time on ultrasound images with the area of interest and compared to a Laplacian enhancement pyramid. The optimum choice of wavelet bases for ultrasound images is investigated in this study. In order to realize a fair comparison, the same nonlinear modification in both Multiscale schemes is used. The comparative analysis shows that the wavelet pyramid gives a much better result than the Laplacian to simultaneous reduction of speckle and enhance the contrast of ultrasound image.

Conclusion: Here the two multiresolution method of enhancement are compared the enhancement by using wavelet and other is the Laplacian pyramid for contrast enhancement. Then the overall result shows in term of counter preservation, error distribution and homogeneity inside the ROI all indicates that the wavelets provides the better overall improvement. A clear difference between the wavelet and Laplacian methods is observed. In particular, the internal variance of the region of interest is much smaller in the wavelet method than the contrast one, which certainly proves better homogeneity which helps for more accurate automatic segmentation. As in the ultrasound images there is much more variability so the wavelet is better than the Laplacian method for overall improvement.[6]

Chien-Cheng Lee, Cheng-Yuan Shih, Shih-Kai Lee, Wei-Tyng Hong(2012), Presents a method of enhancement for blood vessels in retinal images. The method is based on the non sub sampled counter let transform. This transform is a shift invariant version of counter let transform. This is built on the non-sub sampled directional filter bank and non sub sampled pyramid filter bank. The method used the non sub sample counter let transform to decompose the input image into eight directions from finer to coarser scale then classify the pixel into three categories non-vessel, uncertainty, vessel according to non-counter let transform coefficients. These coefficients can be modified according to the class of the each pixel by using mapping function. The enhanced image is reconstructed from the modified non-sample counter let coefficients. The results show that the method can enhance the contrast from the retinal image.

Conclusions: The enhancement method of blood vessel for retinal image by using non sub sampled contour let transform is presented here. Results show that the proposed method is effective and better than the other method for the enhancement of blood vessel. In this the pixels of image can be categories according to non subsample contour let transform coefficients also the each category of pixel is enhance according to their categories and different strategies. Thus this algorithm has a potential for other types of medical image enhancement[7].

S. Hariharan, A. K. Ray, M. K. Ghosh, **(2000)**The physician uses radiographic image most commonly all over the world, for diagnose the disease in medical field. This is because the x-rays are inexpensive and the procedure of x-ray is simple as compared to other imaging techniques. Only one difficulty found in the x-ray films that they are noisy and is very difficult to read even for the experienced physician and radiologists. It is important to develop a technique to enhance the x-ray so that it help physicians and radiologists for diagnosis of disease. In this they proposed an method for enhancement of x-ray image of tuberculosis for better diagnosis of the diseases and remove the noise.

Conclusion: In case of tuberculosis the chest x-ray is very important clinical tool for diagnosis. The x-ray is very noisy and it is difficult to read even for experienced radiologists. They proposed an algorithm for automatic processing of chest x-ray. In the results there are well defined lung boundaries which can provides several clue to the physician and radio logistic to increase the diagnosis.[8]

Ufuk bal, mehmet engine, Urs utzinger(2015) They propose wavelets transform based non-iterative blind deconvolution method. In our proposed deconvolution algorithm, we used wavelet based denoising algorithm. We compare DWT and WPT (discrete wavelet transform and wavelet packet transform) structures as denoising algorithms. WPT based algorithm resulted is less error then the DWT based algorithm .minimum error was obtained for coif wavelets type. We compare our denoising method with several standard denoising. Also, we compared our proposed deconvolution algorithm with several standard deconvolution methods. Our proposed wavelets transform based deconvolution method resulted in the error compared to other methods. To test the efficacy of our deconvolution method on cell images, they proposed wavelet entropy based non reference image quality metric. We tested our

proposed metric by increasing blurring ration both for noiseless and noisy image. Our metric is useful for evaluation image quality in terms of de blurring.

Conclusion: In our proposed wavelet transform –based deconvolution method resulted in the least error compared to other. The error is minimal because our method includes a denoising process. But our method needs further improvement for better contrast enhancement without amplifying the noise .This could done by modifying our denoising process in an iterative manner. We were successful in developing a new image quality metric because there is a good correlation between our entropy-based metric and the blurring ratio. The limitation of our metric is its inability of noise evaluation. It is necessary to evaluate image degradation for both blurring and noise effects. We need to develop a better quality metric which can evaluate both blurring and noise effects together. Our results show that proposed deconvolution method is applicable to fluorescence microscopy images.[9]

M.Y Mashor, M.K OSMAN, Z.saad, H.Jaafa(2009) In the biomedical images there is a very crucial step to segmentation of the tuberculosis bacilli in tissue in computer assisted tuberculosis bacilli detection. In this algorithm the k-mean clustering is used for color image segmentation. The tissue which remains blue after counterstaining process a filter is used to remove blue tissue. After filtering the k-mean clustering with green color component of Red-Green-Blue color model of C-Y color model is used to detect or segment the tuberculosis from the background. That remains red even after decolourization process. After that the median filter and region growing is used to remove the noise component also grow the small region. The proposed methods have been analyzed for several tuberculosis slides image under various conditions. The results indicates that the proposed techniques was successful segment the TB bacilli from its background.[10]

Alexandros Karargyris, Sameer Antani , George Thomas(2009) They describe the development of a screening system in global healthcare setting for tuberculosis application. This approach is method combining of two detection schemes resulting cost. In this approach they used region-based features computed as wavelet features instead of using pixel-wise techniques that take into consideration the orientation of an atomic structure. The results are described. Next step include classification of non-rib lung regions for radiographic patterns suggesting tuberculosis infection.[11]

CHAPTER 3

PRESENT WORK

In this chapter we are going to discuss about the problem formulation objectives and methodology. In methodology we are going to discuss about the method that are used to get the expected outcomes.

3.1 Problem formulation

Enhancement of image plays an important role in the application of image processing. Such as the images from the imagine techniques like X-ray, CT, Ultrasound, etc are not able to provide the complete information about some particular areas of body. With the help of enhancement and detection we can get the maximum information from the images. There are number of techniques to enhance the image in spatial domain and frequency domain but all these techniques have there on advantages and disadvantages. At first discuss the spatial domain enhancement techniques first one is the linear transformation, in which the only negative of the image is found. This technique is used for enhancement gray or white detail is in dark regions of image. Similarly in the logarithmic enhancement it compresses the range of image that has variation in their pixel intensities. In gamma correction or the power law transformation is also useful for contrast manipulation for e.g. MIR image of head this is predominantly dark and for this the expansion of gray level is desirable. The histogram is the basic for the numerical spatial domain technique. Histogram calculation is used for the image enhancement. The information present in the image histogram not only provides useful statics but it useful in another processing application such as segmentation and image compression. Above techniques are not used in the segmentation or we can say that detect the abnormalities from the image so I use the histogram equalization technique as enhancement of image, and use loggabor filter with gradient mask to detecting the abnormal part. In my algorithm I can find out the features from the input x-ray image with the loggabor filter and applying gradient mask to detect the tuberculosis after this we enhance the image then apply loggabor filter and dilated gradient mask again to detect the tuberculosis, The result of the enhancement gives the better result of detection.

3.2 Objectives

Based on the literature review, the objective of the research is to enhancement of the x-ray image and detection of tuberculosis from the x-ray for better diagnosis of diseases by the doctor. This objective can be achieved by following:

- Detection of tuberculosis from the input x-ray image.
- Enhancement of the x-ray image by histogram equalization.
- To do the comparative analysis between detection before enhancement and after enhancement. The area of detection is increase after the enhancement.

3.3 Proposed work and methodology

In this dissertation-2 the work is divided into many parts. First find the features of the image then classified the features and then detect the tuberculosis. After this enhance the image and again detect the tuberculosis from the chest x-ray. Compare the results of detection before and after enhancement. Detection after enhancement gives the better results than detection before enhancement.

3.3.1 Flow chart of Image Enhancement and Detection

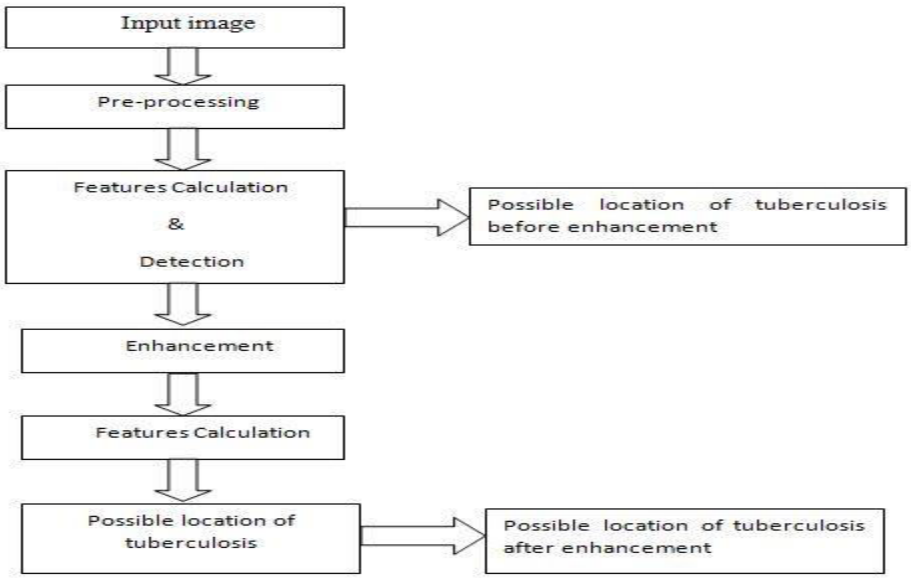


Figure 3.1 Flow chart of image enhancement and detection

3.3.2 Pre-processing stage

There is need of pre-processing so that the quality of image can be enhanced. As the results of all algorithms highly depends upon the quality of the images. At the time of image capture various unwanted effects includes with the image such that shadowing effect or illumination change may degrade the quality of image. So pre-processing is very useful to remove these unwanted effects. It performs the operation to remove unwanted information while provide the local information of an image. But this step is only required if redundant information, noisy or unreliable data is present in the image.

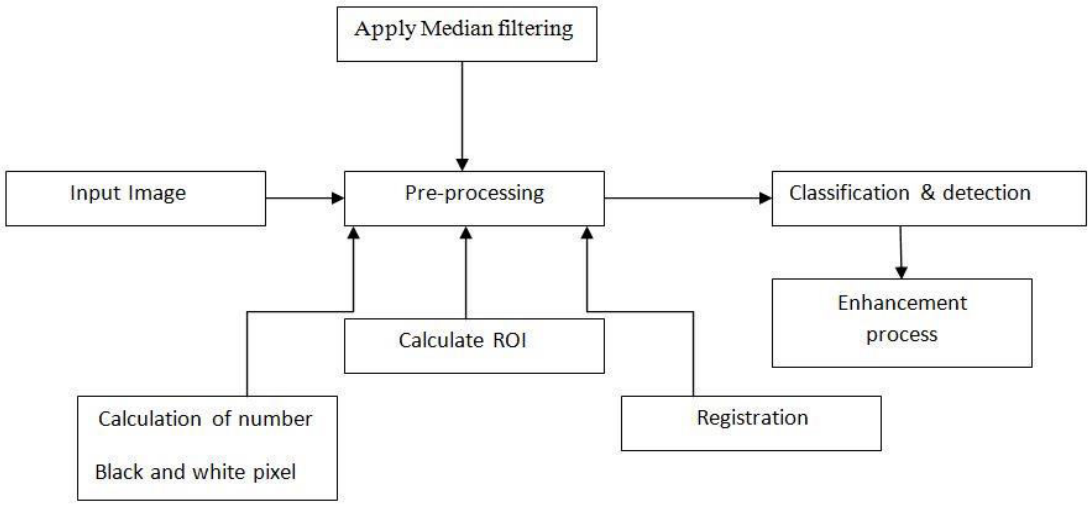


Figure3.2 Pre processing stage

Median filtering

The median filtering is done to remove the effect of the Sharpe noise. There is some Sharpe noise present in the image that can remove before applying detection algorithm because some of noise part also detect if the noise is present there.

Evaluation Parameters

For evaluation of enhanced image that is to check the quality of fused image in comparison of input image some parameters are used like mean square error (MSE), peak signal to noise ratio (PSNR), and many other parameters. Also these parameters can be calculated from the input image or with detected image. Also we calculate the area of detection of tuberculosis

before enhancement and after enhancement. The quality of image only predicted with the help of these evaluation parameters that is how much the quality of image has been improved.

3.3.3 Classification

Classification is done to check the properties of the image. We find the border of the image pixels. Then fill the holes from the image. Check the black and white image according to thresholding. Rotate the image to check the effect of rotation in the image. Also find the maximum region of the image. The edges are finding with the help of mask some of edge detection operators are Sobel, Prewitt, canny

3.3.4 Edge detection

Canny operator

In this edge detection canny proposed three criteria of the evaluation: (1) the probability of real edge detection is higher and the probability of non-edge point is lower by the standard of signal to noise, output of signal to noise ratio is maximum.2) The possibility of edge detection is actually in the center of edge i.e. the standard of positioning accuracy is good (3) Single edge give the less probability of multiple response, and maximum stopping for the false edge.

Canny operators are depends on these three criteria. For smoothing the image Gaussian function is used. After this the maximum of first derivative relates to the minimum of first derivative [16]. In simple words the point of abrupt changes of gray scale and the point with slow changes weak edges relate to the zero crossing point. Only the disadvantages of this operator are to detect the weak edge.

Sobel operator

Sobel operators are working as a filtering operator. The edges are extracting with these operator. There are two nuclear convolutions at the each point in the image. The maximum response of verticals edge is check with the help of one convolution and convolution is check response of horizontal edge[17]. These operator are very easy to found in space, with the very accurate edge direction information it also detect many false edges with wider width

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

Sobel operator

PREWITT OPERATOR

These operators are type of edge model. The Prewitt operator formed by the two convolution kernels. The image is detected by using edge model one by one, the detection region as the output of the operator is similar the maximum value of model operator. The prewitt operator and the Sobel operator are the same in their operation, only one difference b/w these operator is that the template do not use the same image.

3.3.5 Detection before enhancement

At the first stage of detection select the target area i.e. the lung part convert it to double for further processing. Then apply the log Gabor filter to the image.

Log Gabor filter

In the image processing the log Gabor filters are widely used. The kernels of these wavelets have many properties. These properties of wavelet kernels made selectively spatial frequency characterization and localization which means that these filter have best simultaneous frequency localization and have information in spatial plane. These filters are very successful but only have a one limitation that is the bandwidth limitation. To overcome these problem have to maintain maximum spatial localization and obtained maximum spatial information. For this a new filter is introduced called log Gabor filter.

Thresholding

Apply the thresholding to the log Gabor filter output image this is apply to computes a global threshold that can be used to convert an intensity image to a binary image. This function uses

Otsu's method, which chooses the threshold value to minimize the intra class variance of the black and white pixels.

Dilated gradient mask

Binary gradient mask is applied to image filtered bye the loggabor filter. Gradient mask shows lines of high contrast in the image.

Dilation

The dilation operation is denoted by X⊕B and defined as:-

$$\boldsymbol{X \oplus B = X + b = \{x + b: X \& b \epsilon B\}}$$

X is the gray scale image B is the structuring element. The output of the dilation is set of translated points. The translation of structuring element has non empty intersection with the gray scale image. The dilation of X by the factor B is the set of the all displacement. Such that x and b overlap by the at least one structuring element. The bridging of gap is simplest application of the dilation operation. The gap is repaired with the help of the structuring element.

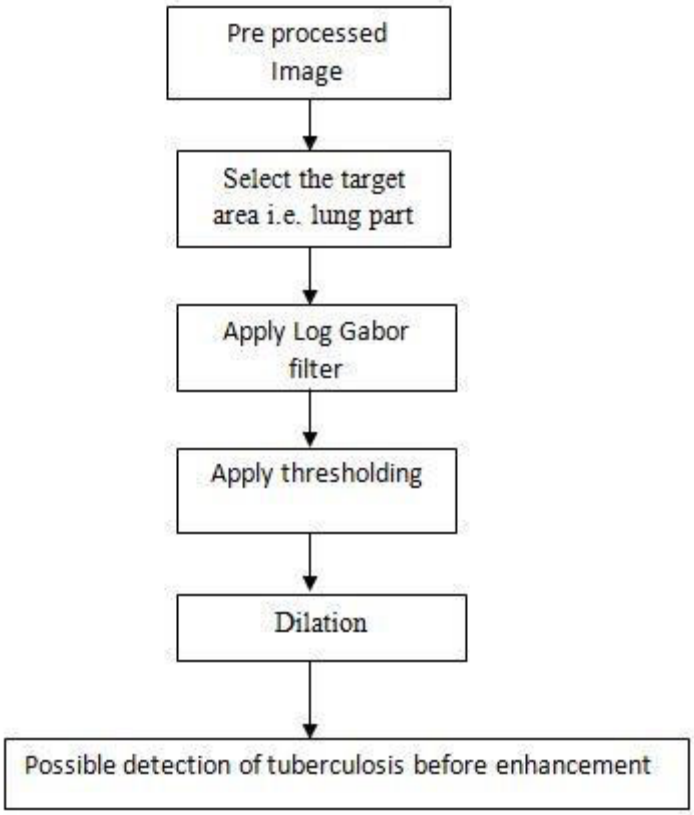


Figure 3.3 Detection before enhancement

After the dilation process the possible area of tuberculosis part is found. Mark the detected part with red color and calculate the area of the tuberculosis. Also find the PSNR and MSE of the output image and input image.

3.3.5 Detection after enhancement:

Histogram

Histogram of the image with gray level [0, L-1] is a discrete function h ($r_{k)}$ = $n_{k.}$ Here r_k is the kth gray level and n_k is no of pixel having gray level $r_{k.}$ Basically normalize a histogram by dividing each of its value by the total no of pixel in the image denoted by n. The normalize histogram is produced by P (r_k) = n_k/n, for k=1, 2…L-1, where P (r_k) is estimate of probabilities of occurrence of gray level.

Histogram is the basis for the numerical spatial domain processing techniques. Histogram calculations are used for the image enhancement. The information in the image histogram not only provides useful statistic but it useful in another processing application such as image segmentation and image compression. Histogram can we find with the help of software and implement in the hardware. It is a popular real time image processing.

Histogram equalization

The histogram equalization is done to get the uniform distribution of pixel intensity. This is the most basic enhancement techniques.

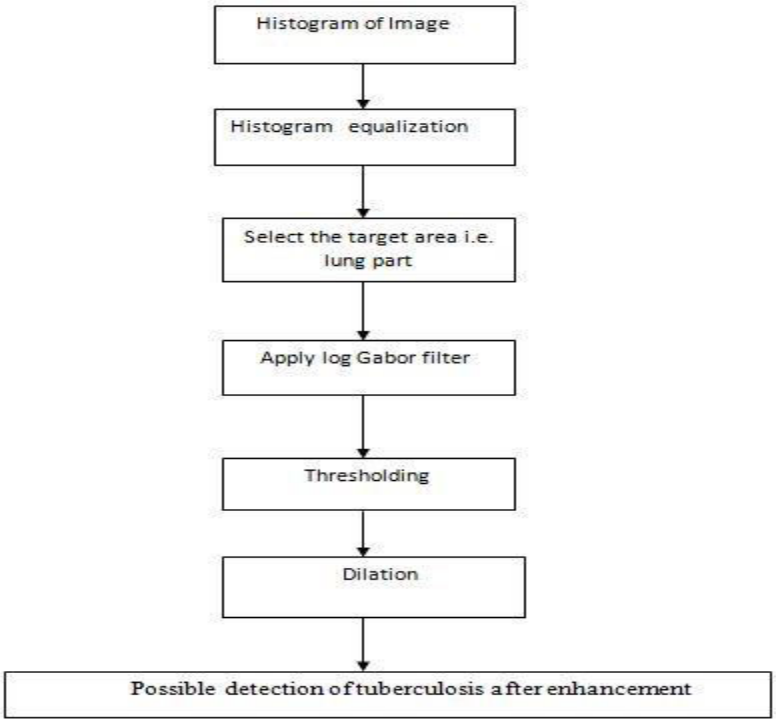


Figure 3.4 Detection after enhancement

CHAPTER 4

RESULT AND DISCUSSION

In this chapter the result of different parts are shows. By applying the different functions in my algorithm I get the different results that are shown in these chapter also different parameters and analyze the results. Image enhancement and detection of tuberculosis has been performed by using basic histogram equalization technique the detection of tuberculosis part is done with the help of loggabor filter. First I detect the tuberculosis without enhancement and then did the enhancement. The main aim of this dissertation-2 is to enhance the quality of degraded image by using enhancement process also the detection is done for the x-ray image to detection of the tuberculosis.

4.1 Outputs of preprocessing stage

In this stage the input is x-ray image of tuberculosis patient. If the input image is RGB then converted it into the Gray scale image.

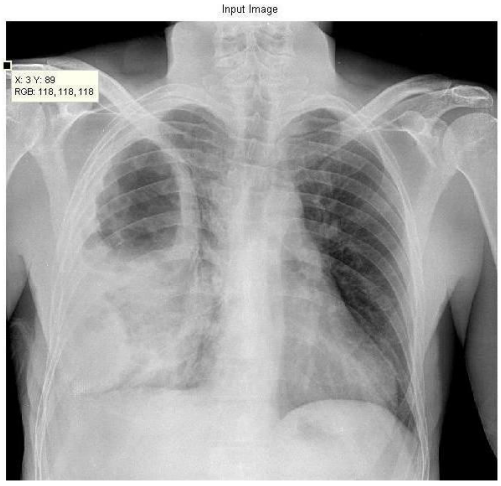


Figure 4.1 Input image

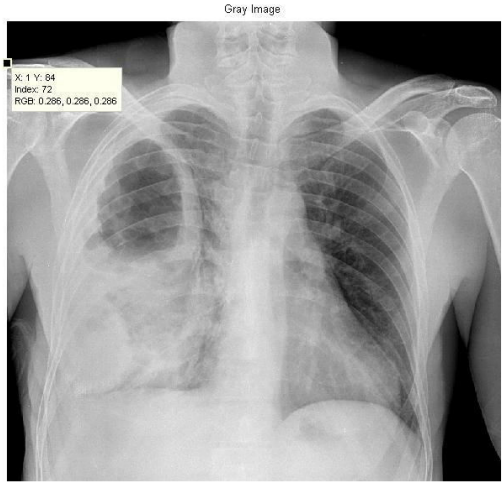


Figure 4.2 Gray scale

4.1.1Median Filtered image

The median filtering is used in the preprocessing step median filter is applied to the input image to reduce the noise and smoothing of input image

Figure 4.1 median filter images

4.1.2 Threshold, eroded and dilated image

The thresholding is applied to find the region of interest then the image is eroded first and then dilate the image is eroded to shrink the small particles and then apply dilation

Figure4.4 Thresholding

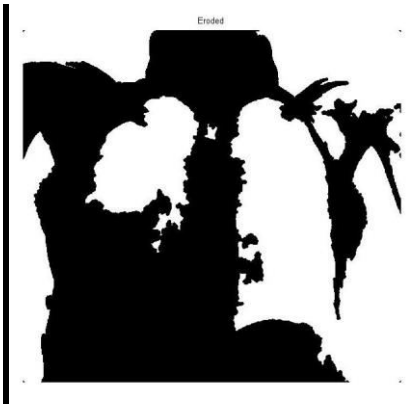


Figure 4.5 Eroded

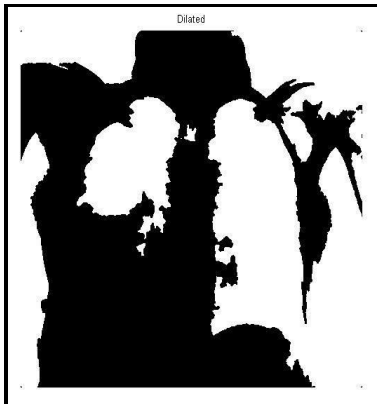


Figure 4.6 Dilated

4.2 Detection

At this step the tuberculosis part is detected from the image. The loggabor filter is applied to the preprocessed image then dilated gradient mask is applied to the filtered image to detect the tuberculosis area at the end dilate the detect area and the final possible location of tuberculosis is detected.

4.2.1 Log Gabor filter results

Figure 4.7 Gabor filter results

4.2.2 Dilated gradient mask, Clear border Image & Dilated detected portion

Figure 4.8 Dilated gradient mask

Figure 4.9 clear borders

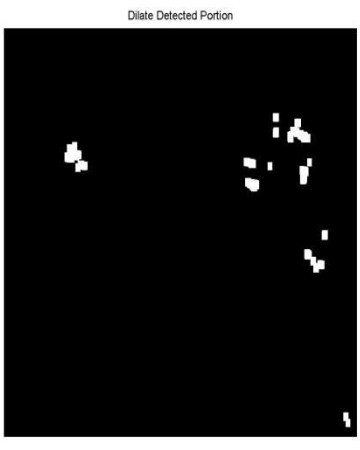


Figure 4.10 Dilated detected portion

4.3.3 Possible location of TB:

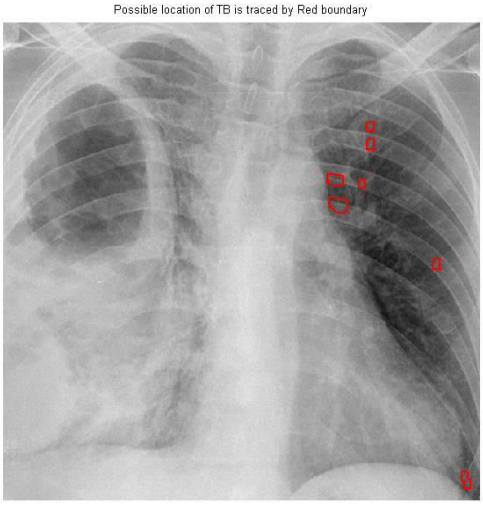


Figure 4.11 Possible location of TB

4.3 Enhancement

Image enhancement is done to extract or bring out important detail from the digital image, or simply to highlighted important features of our interest in that image.

4.3.1Histogram and histogram equalization:

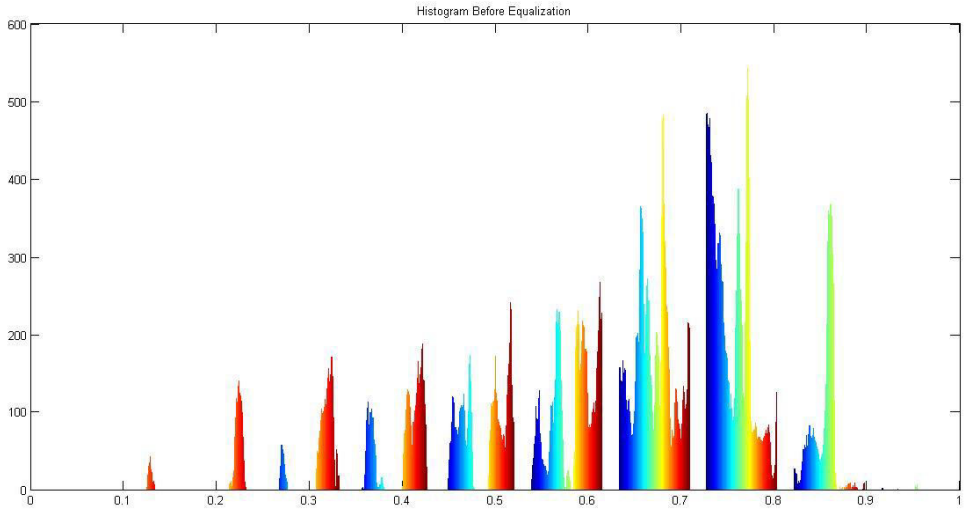


Figure 4.12 Histogram of the image

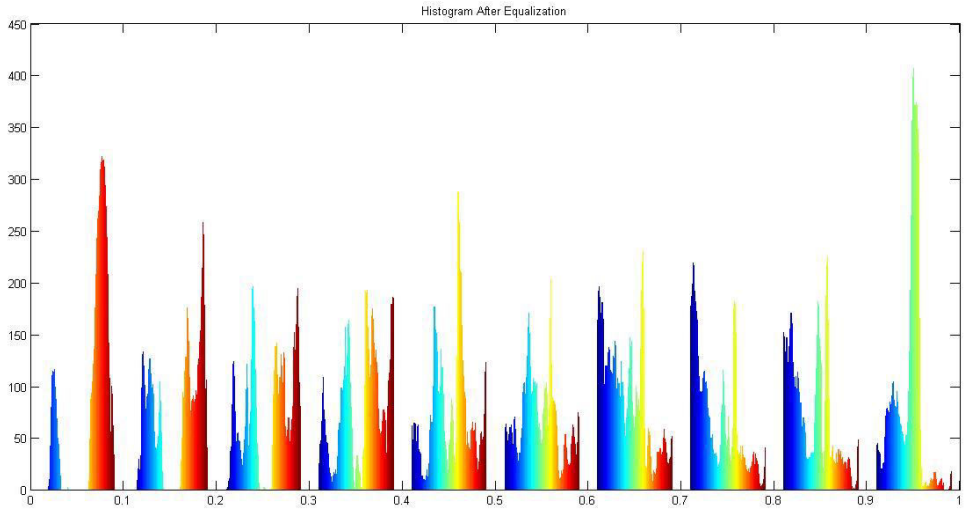


Figure 4.13 Histogram equalization

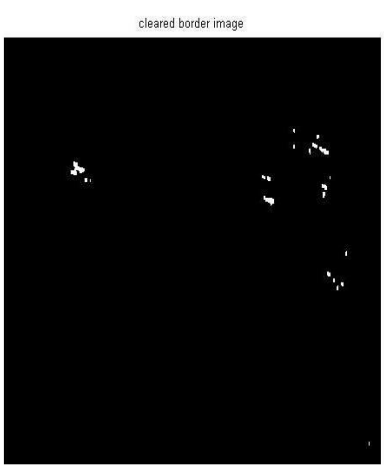
4.4Detection of tuberculosis after enhancement

At this step the tuberculosis part is detected from the image. The loggabor filter is applied to the enhanced image then dilated gradient mask is applied to the filtered image to detect the tuberculosis area at the end dilate the detect area and the final possible location of tuberculosis is detected. The results of this part are:

4.4.1 Output of Loggabor filter

Figure 4.14 loggabor filtered image

4.4.2 Dilated gradient mask clear border and dilated detected portion image



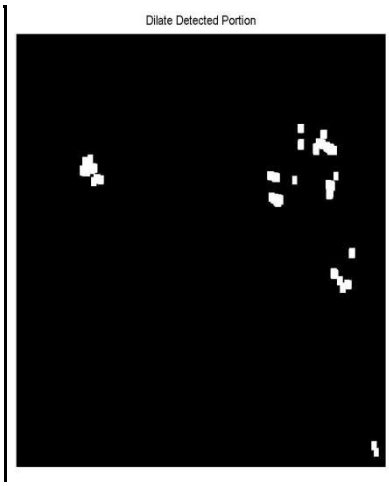


Figure 4.15 Dilated gradient mask **Figure 4.16** Clear border **Figure 4.17** Dilated detected portion

4.4.4 Possible location of tuberculosis

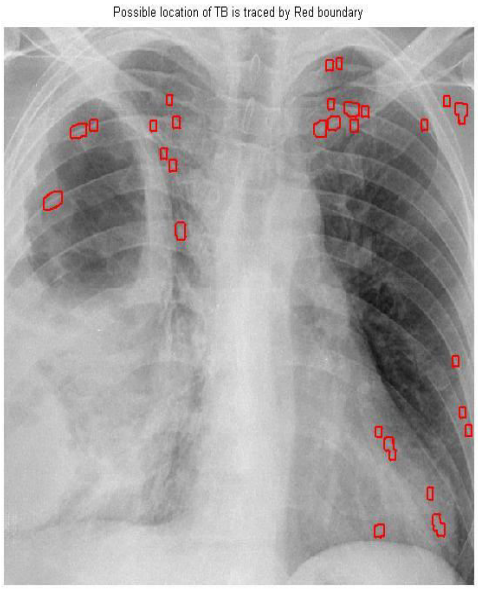


Figure 4.18 Possible location of tuberculosis after enhancement

CHAPTER 5

COMPARITIVE ANALYSIS

Image enhancement and detection of tuberculosis is done here. In this First we detect the tuberclosis. We use loggabor filter which helps in find the abnormalities in the image. After finding these abnormalities apply the dilated gradient mask to detect the abnormalities. After detecting the tuberclosis, enhanced the image so that tuberclosis is detected again more clearly. This increases the quality of the detected part. This helps in detecting the area more accurately. As shown in figure 5.1 area calculated according to our methodology is more as compared to methodology without enhnacement.

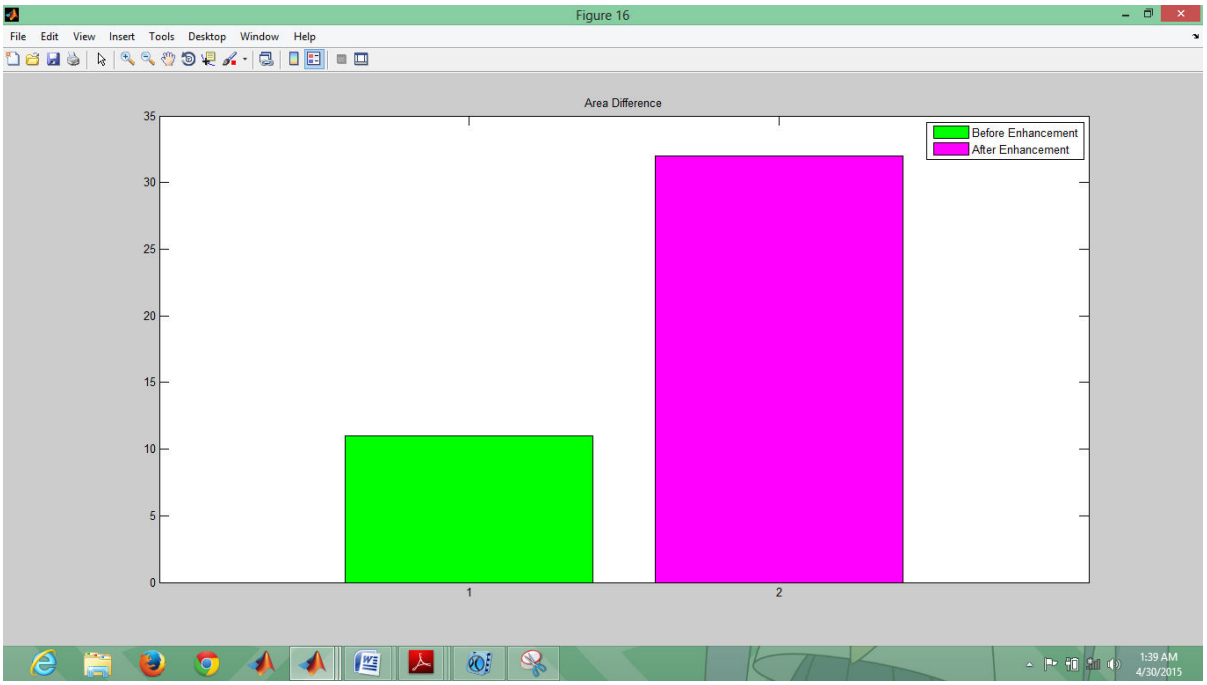


Figure 5.1 Comparison of Possible detected area of tuberculosis before and after enhancement

CHAPTER 6

CONCLUSIONS AND FUTURE SCOPE

In this chapter overall procedure is concluded, also discuss about the future scope of the dissertation.

6.2 CONCLUSION

For the image enhancement and detection of tuberculosis there are many techniques but this dissertation based on histogram equalization for enhancement and loggabor filtering for detection of tuberculosis. As detection of tuberculosis doesn't give the good result, all part of tuberculosis from the x-ray cannot detect. So this dissertation remove that problem by using proposed technique in which x-ray image is enhanced then apply the log Gabor filter. At first in this algorithm we calculate features from the image then classified these features and analyze these features to detect the tuberculosis. Then apply the log Gabor filter to the x-ray and detect the tuberculosis. In this compare the area of possible detection of tuberculosis before enhancement and after enhancement. This algorithm gives the better results for detection of tuberculosis and used for any application of image processing.

6.2 FUTURE WORK

In the future, there is way to shift towards another enhancement algorithm before detection of tuberculosis. This dissertation, based on basic histogram equalization technique to enhance the input x-ray image before detection. There are many other enhancement techniques in the image processing fields that gives the better results of enhancement due to this detection is more accurate which makes the diagnosis more easy for doctors.

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Appendix A: Abbreviations

Term	Abbreviation
DWT	Discrete Wavelet Transform
WPT	Wavelet Packet Transform
SRFC	Speckle Reduction Frequency Compounding
SRSC	Speckle Reduction Spatial Compounding
SRPF	Speckle Reduction Post filtering
GSM	Global Scale Mixture
RGB	Red Green Blue