CHAPTER 5

PREPROCESSING AND ENHANCEMENT

5.1 PREFACE

The objective of image enhancement is to improve the interpretability of the information present in the images for human viewers. An enhancement algorithm yields better-quality images for the purpose of some particular identification which can be done by either suppressing the noise or increasing the image contrast. Image enhancement algorithms are employed to emphasise, sharpen or smoothen image features for display is one that the preprocessing and enhancement is essential step for mammogram image segmentation. This work, mammogram image are preprocessed and enhanced using low pass filter, high pass filter, pixel intensity transformation, contrast stretching and region growing technique.

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Preprocessing and Enhancement

- Low Pass Filter
- High Pass Filter
- Median Filter
- Contrast Stretching
- Logarithmic Transformation
- Pixel Intensity Transformation
5.2 FILTERING TECHNIQUE

The low pass filter and high pass filter [6] are widely using in image processing. Any image can be viewed as costing of gray details corresponding to low frequency and high frequency for example, the high frequency components correspond to edge and other sharp details in image. So when we employ a high pass filter to process an image, the details corresponding to edge and other sharp details are highlighted and low-frequency details are attenuated. Hence the high pass-filter can be used in obtain the boundary of the objects and other sharp details available in image.

Similarly, the low-frequency details correspond to slowly varying the components of an image. So when we employ a low pass filter to process an image it allows only slowly varying image details and attenuate heavily the details corresponding to edge and sharp transitions and result in a blurred image. In this research work low pass filter, high pass filter, median filter technique are applied to enhance the mammogram image.

5.2.1 Low Pass Filter

The low pass spatial filters are used to reduce the noise such as bridging of small gaps in the lines or curves in an image. So the low pass filter is also called as smoothing filters. For a 3 x 3 Spatial filter easiest arrangement is to have a mask in which all the coefficient have value 1. The 3 x 3 mask with coefficient is shown in the figure. The mask can also be larger than 3 x 3. As the size of the mask increase the smoothing effect also increase. This filter is used to remove the noise from the mammogram image.
5.2.2 High pass Filter

The high pass filters attenuates low frequency components heavily and pass the high frequency components. The results in an image with sharp details such as edge and high contrast. It is can provide more visible details that are obscured, hazy, and poor focus in the original image. We have to construct a mask such that the center of the mask has positive value and all its neighbor coefficients are of negative value.

When we operate this mask to an image starting from left corner and slide one portion to the right till it reaches the last position in a image. The logic behind the high pass filter is mask be at a location where the pixel beneath have equal values corresponding o the background of an image. These filters are used to enhance the mammogram image.
Fig 5.4 (a) Original Image

Fig 5.4 (b) High Pass Filter Image
5.2.3 Median Filter

The Median filter is statistical non-linear filters that are often described in spatial domain. A median filter smooths the image by utilising the median of the neighbourhood. It was introduced by Tukey 1997. Its extension to two dimensional images was discussed by Patt in 1998.

The median filter considers each pixel in the image in turn and looks at its nearby neighbours to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighbouring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value.

An example of mean filtering of a single 3x3 window of values is shown below.

Unfiltered values

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>5</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

Fig 5.5 Pixel Values Under Mask of 3x3

This filter is applied to enhance the mammogram image.
Filter Value

5+3+6+2+1+9+8+4+7=45

45 / 9 = 5

5.2.4 Contrast Stretching

Sometime during the image acquisition low contrast image may result due to one of the following such as poor illumination, lack of dynamic range in the image sensor and wrong setting of the lens aperture. The idea behind the contrast stretching is to increase the dynamic range of gray levels in the image being processed. The brightness of an image depends on the value associated with the pixel of the image. When changing the brightness of an image, a constant is added or subtracted form the luminance of all sample values.

The brightness of the image can be increased by adding a constant value to each and every pixel of the image. Similarity the brightness can be decreased by subtracting a constant value from each and every pixel of the image.

5.2.4.1 Increasing the brightness of an image:

To increase the brightness value of an image is to add a constant value to each and every pixel of the image. If \( f[m,n] \) represents the original image then a new image \( g[m,n] \) is obtained by adding a constant \( k \) to each pixel of \( f[m,n] \). This represented by

\[
g[m,n] = f[m,n] + k
\]

In the above formula are applied to increase brightness of the mammogram image.
5.2.4.2 Decrease the brightness of an image:

The brightness of an image can decrease by subtracting a constant $k$ from all the pixels of the input image $f[m,n]$. This is represented by

$$g[m,n] = f[m,n] - k$$

5.2.5 Logarithmic Transformation

Logarithmic and contrast-stretching transformations are basic tools for dynamic range manipulation. Logarithmic transformations are implemented using expression

$$g(m,n) = c \cdot \log_2(f(m,n) + 1)$$

Where $c$ is a constant.

This type of mapping spreads out the lower gray levels. For an 8 bit image, the lower gray level is zero and the higher level is 255. It is desirable to map 0 to 0 and 255 to 255. The function of $g(m,n) = c \cdot \log_2(f(m,n) + 1)$ spread out the lower gray levels.
Fig 5.7 (a) Original Image

Fig 5.7 (b) Brightness Increased Image
Fig 5.9 (a) Original Image

Fig 5.9 (b) Logarithmic Transformation Image
5.2.6 Gray Level Transformation

The Gray level transformation can be classified two types, such as Linear Gray level transformation and Non Linear Gray Level Transformation [99].

5.2.6.1 Linear Gray Level Transformation

A linear transformation of an image is a function that maps each pixel gray-level value into another gray-level at the same position according to a linear function.

Inverse transformation

The inverse transformation light and dark. An example of inverse transformation is an negative image. A negative image is obtained by subtracting each pixel from the maximum pixel value. The negative image can be obtained by reverse scaling of the gray levels according to the transformation. It is represented by

\[ g(m,n) = 255 - f(m,n) \]

The figure 5.1 a shows the original image and 5.1 b shows inverse transformed image.
Fig 5.10(a) Original Image

Fig 5.10 (b) Inverse Transformed Image
5.2.6.2 Non Linear Gray Level transformation

The Non linear gray level transformation maps small equal into non equal intervals. Some of the non-linear transaction such as t gray level slicing logarithmic transformation and many more.

5.2.7 Gray Level Slicing

The purpose of gray level slicing is to highlight a specific range of gray values. The two different gray level slicing one is gray level without preserving background another one is gray

5.2.7.1 Gray Level Slicing without Background.

Gray level slicing without preserving background is display high values for a range of interest and low values in other areas. The main draback of this approach is that background information are discarded.

5.2.7.2 Gray Level Slicing with background

In gray level slicing with background, the objective is to display high values the range of interest and original values in others area. This approaches preserves the background of the image.
Fig 5.12 (a) Original Image

Fig 5.12 (b) Gray Level Slicing without Background
5.3 SUMMARY

This chapter has proposed different filtering techniques used to enhance the mammogram image that is very useful for further analysis of breast cancer. Initially the mammogram image is acquired from MIAS database is given to MATLAB. After acquisition the MRI is given to the preprocessing stage, here the film artifacts labels are removed. Next, the high frequency components and noise are removed from mammogram using the following filters. Such as Median filter, Low pass filter, High pass filter, Contrast Stretching and Gray Level Transformation. The Computational result is used to enhance the Image and the performance of the system was investigated.