A Research on Various Filtering Techniques in Enhancing Mammogram Image Segmentation

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Abstract- Breast cancer is the most common death causing cancer among women. Finding an efficient and accurate segmentation techniques still remains a challenging problem in digital mammography. Pre-processing of images play a vital role in efficient segmentation because of several factors which affects the efficiency and accuracy of further processing. This paper aims to study various available pre-processing approaches and finds the best suitable existing approach for enhancing medical mammogram images for better representation. Performance of the filters are evaluated using Peak signal to noise ratio and Mean Square Error approaches and compared against each other for different noises.

Keywords- Filter, Enhancement, Pre-processing, Mammography and Breast Cancer.

I. INTRODUCTION

The early detection of breast cancer can be key to survival. Breast self-examinations, clinical breast exams by the experts, and screening mammography are essential methods which are used to detect the cancer in breasts at an early stage. There are a several factors associated with effective mammogram segmentation. Super imposition of several types of tissues in the breast region makes it very difficult to differentiate and identify the regions. Several steps are involved in efficient segmentation of mammogram image. It involves mammogram image pre-processing, enhancement and segmentation.

Digital mammogram images are acquired from mini MIAS database. The images are digitized at 200 micron pixels edge and padded in order to obtain all images with a size of 1024 × 1024 pixels as shown in figure 1a).

II. IMAGE ENHANCEMENT

Mammogram image enhancement is the process of manipulation of images by reducing noises and increase the image contrast in order to detect the abnormalities. The methods used to manipulate mammogram images can be categorized into four main categories namely the conventional enhancement techniques, the region-based, feature-based and fuzzy enhancement techniques.

Conventional enhancement techniques used to modify the mammogram images based on the global properties as it is a fixed neighbourhood technique. Region-based techniques are used for contrast enhancement of mammogram images in accordance to its surroundings. Feature based methods are based on wavelet domain enhancement techniques. The fuzzy enhancement techniques apply fuzzy operators and properties to enhance the mammogram image.

A. Noise Removal

Images acquired from the real world are subjected to various types of noises. Noises such as marks and lines are present in the majority of acquired mammogram images. For effective processing these noises should be removed before processing the image. This can be accomplished by using filters. Filters like mean, median, average filter, wiener filter, spatial low pass filter, Gaussian filter, bilateral filter, Butterworth filter and wavelet filters are applied to noise image to compare and find which filter yields the best quality to the original image.

For example Salt and pepper noised image as shown in Figure 1.b) is filtered using a 2-D Median filtering approach using a 3-by-3 neighbourhood connection and Spatial Filtering. Each output pixel in filtered image contains median value of neighbourhood to the corresponding pixel in the input images as shown in figure 1c.

Figure 1 a) Original Image b) Salt & Pepper Noised image c) Median Filtered image
d) Spatial low Pass Filtered Image e) Wiener Filter f) Bilateral Filter
III. PERFORMANCE ANALYSIS

Aim of this paper is to find the filter which performs best in extracting the image from noisy mammogram image. In order to find the effective one, performance of the filters are analysed and compared against each other. Resulted extracted images from noisy images are compared with original images. This involves number of steps like

1. Load the Original input mammogram image.
2. Add noise manually to evaluate the performance of filers to various noises.
3. Apply various filters to different noises.
4. Calculate Mean Square Error and Peak Signal Noise Ratio
5. Compare the performance of various filter against each other for various noises added to original images.

The noises are added to the original image manually of various intensities. Then filters are applied to those noises and results are compared against each other to find the better one.

A. Mean Square Error

The mean-square error is an average or expected value of squared error or loss. It can be calculated by using the following equation:

\[ \text{MSE} = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (I_{1}(i,j) - I_{2}(i,j))^2 \]  

where \( M \) and \( N \) represents the number of rows and columns in the input images \( I_1 \) and \( I_2 \).

B. Peak Signal Noise Ratio

One main disadvantage of MSE is that it depends strongly on the image intensity scaling. Peak Signal-to-Noise Ratio (PSNR) avoids this problem by scaling the MSE according to the image range:

\[ \text{PSNR} = -10 \log_{10} \frac{R^2}{\text{MSE}} \]  

where \( R \) is the maximum pixel value. PSNR is measured in decibels (dB). The measure of the signal strength by means of square is the main disadvantage of PSNR.

IV. EXPERIMENTAL RESULTS

The performance of various filters applied to noises are evaluated and compared in terms of Peak Signal Noise ratio and Mean Square Error. The values are tabulated as shown in Table I & II and Figure 5.

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>MEAN SQUARE ERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter</td>
<td>Average Filter</td>
</tr>
<tr>
<td>Poisson Noise</td>
<td>0.0002</td>
</tr>
<tr>
<td>Gaussian Noise</td>
<td>0.0015</td>
</tr>
<tr>
<td>Salt &amp; Pepper</td>
<td>0.0026</td>
</tr>
<tr>
<td>Speckle Noise</td>
<td>0.0006</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>TABLE II</th>
<th>PEAK SIGNAL NOISE RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise/Filter</td>
<td>Average Filter</td>
</tr>
<tr>
<td>Poisson Noise</td>
<td>85.232</td>
</tr>
<tr>
<td>Gaussian Noise</td>
<td>64.088</td>
</tr>
<tr>
<td>Salt &amp; Pepper</td>
<td>57.337</td>
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<tr>
<td>Speckle Noise</td>
<td>73.340</td>
</tr>
</tbody>
</table>
V. CONCLUSION

Several filters have been applied to different types of noises with varying levels. The performance of those filters is calculated and plotted in terms of peak signal noise ratio and mean square error. Among all the filters that have been experimented, median and spatial low pass filter performs well against noises. Spatial filters yield better outcomes for images with Poisson and Speckle noise. Median filter performs well against Gaussian noise and its best against Salt and Pepper noise images. Images can be further enhanced using contrast adjustment and histogram equalization methods to make it easier and efficient for processing.

REFERENCES

[9]. www.mathworks.in/help/vision/ref/psnr.html