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Mammogram Image Preprocessing for detection of masses in Breast Cancer

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Abstract

Breast cancer is the most commonly observed cancer in women both in the developing and the developed countries of the world . Cancer refers to the uncontrolled multiplication of a group of cells in a particular location of the body. A group of rapidly growing or dividing cells may form lump or mass of extra tissue. These masses are referred to as tumors. Cancer cells are termed as malignant tumors. Any form of malignant tumor developed from breast cells is nothing but breast cancer. Breast cancer detection is the standard diagnosis and prognosis. Digital Mammogram has considered as the most popular screening technique for early detection of Breast Cancer and other abnormalities. Digital mammograms are medical images that are difficult to interpret, Develop Computer Aided Diagnosis (CAD) systems that will improve detection of abnormalities in mammogram images. In this paper we present detection of abnormal masses by preprocessing of Breast Images, Region of Interest (ROI). The filters proposed are fully able to isolate and abnormal regions in the breast tissue, If any abnormalities are present it gets accurately highlighted by this filtering and mammogram image preprocessing.

Keywords: Digital Mammogram, Breast cancer detection, filters.

Introduction

Presently breast cancer detection plays a very important role for worldwide women to save the life. Doctors and radio logistic can miss the abnormality due to inexperience in the field of cancer detection. The preprocessing is the most important step in the mammogram analysis due to poor captured mammogram image quality. The objective ofpreprocessing is to improve the quality of the image and make it ready for further processing by removing the irrelevant noiseand unwanted parts in the background of the mammogram. Pre-processing is very important to correct and adjust the mammogram image for further study and processing. There are different methods of preprocessing a mammogram image. There are Different types of filtering techniques available for preprocessing. These filters used to improve image quality, remove the noise, preserves the edges within an image, enhance and smoothen the image. In this chapter, various filters are explored namely, average filter, adaptive median filter, average or mean filter, and wiener filter.

1. Preprocessing

Image preprocessing techniques are necessary, in order to find the orientation of the mammogram, to remove thenoise and to enhance the quality of the image [3]. Before any image processing algorithm can be applied on mammogram,preprocessing steps are very important in order to limit thesearch for abnormalities without undue influence frombackground of the mammogram.Digital mammograms are medical images that are difficult to be interpreted, thus a preparation phase is neededin order to improve the image quality and make thesegmentation results more accurate. The main objective ofthis process is to improve the quality of the image to make itready to further processing by removing the unrelated andsurplus parts in the background of the mammogram.Breast border extraction and pectoral muscle suppressionis also a part of preprocessing. The types of noise observed inmammogram are high intensity rectangular label, lowintensity label, tape artifacts etc.,[4]. The types of noisespresent in mammogram are represented in Figure 1. Preprocessing may also involve in creating mask for pixels with highest intensity, to reduce resolutions and to segmentthe breast [5].The main goal of the pre-processing is to improve the image quality to make it ready to further processing by removing or reducing the unrelated and surplus parts in the background of the mammogram images. Mammograms are medical images complicated to interpret. Hence preprocessing is essential to improve the quality. It will prepare the mammogram for the next two-process segmentation and feature extraction. The noise and high frequency components are removed by filter

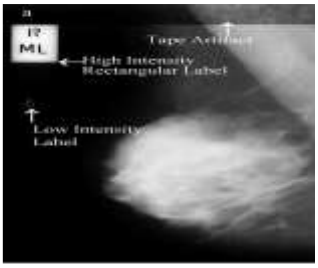


Figure 1. Types of Noise observed in Mammogram

2. Filters

*2.1 Mean filter or Average filter:*The goal of the mean filters used to improve the image quality for human viewers. In this, filter replaced each pixel with the average value of the intensities in the neighborhood. It locally reduced the variance, and easy to carry out [18]. Limitations of average filter:

i. Averaging operations lead to the blurring of an image, blurring affect features localization.

ii. If the averaging operations applied to an image corrupted by impulse noise, the impulse noise attenuated and diffused but not removed.

iii. A single pixel with a very unrepresentative value affected the mean value of all the pixels in neighborhood significantly.

*2.2 Median filtering:*A median filter is a nonlinear filter is efficient in removing salt and pepper noise. Median tends to keep the sharpness of image edges while removing noise. The different types of median filters are: 1.Centre-weighted median filter, 2.Weighted median filter. 3. Max-median filter, the effect of the size of the window increases in median filtering noise removed effectively.

*2.3 Adaptive Median filter:*Adaptive median filter works on a rectangular region S_{xy}. It changes the size of S_{xy} during the filtering operation depending on certain conditions as listed below. Each output pixel contains the median value in 3-by-3 neighborhood around the corresponding pixel in the input images. Zeros however, replace the edges of the images [19]. The output of the filter is a single value, which replaces the current pixel value at (x, y), the point on which S is centered at the time. The following notationsare used:

Z_{min} = minimum pixel value in S_{xy}

Z_{max} = maximum pixel value in S_{xy}

Z_{med} = median pixel value in S_{xy}

Z_{xy}= pixel value at coordinates (x, y)

S_{max}= maximum allowed size of S_{xy}

Adaptive median filtering is used to smooth the non-repulsive noise from two-dimensional signals without blurring edges and preserved images. This makes it particularly suitable for enhancing mammogram images. These preprocessing techniques are used in mammogram, orientation, label, artifact removal, enhancement and segmentations. The preprocessing involved in creating masks for pixels with highest intensity, to reduce resolutions and to segment the breast [20].

2.4 Wiener filter: The Wiener filter tries to build an optimal estimate of the original image by enforcing a minimum mean square error constraint between estimate and original image. The Wiener filter is an optimum filter. The objective of a wiener filter is to minimize the mean square error. A Wiener filter has the capability of handling both the degradation function as well as noise. From the degradation model, the error between the input signal *f(m, n)* and the estimated signal *f(m, n)* is given by

$$E(M, N) = F(M, N) - F(M, N) \qquad (1)$$

The square error is given by

$$[F(M, N) - F(M, N)]^2 \qquad (2)$$

The mean square error is given by

$E\{[F(M, N)-F(M, N)]^{2}\}$ (3)

3. Performance Evaluation Parameters

The objective measures of picture quality that are based on computable distortion measures like mean square error, peak signal to noise ratio, average distance, maximum difference, normalized correlation, mean absolute error, normalized error, structural correlation are considered for study in this work on the original image *f(i, j)* and on the decompressed image *f'(i, j)* [21],[22].

3.1 Mean Square Error: The Mean Square Error is most common form of image quality for any images. The simplest of distortion measurement is Mean Square Error (MSE), defined as,

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}[f(i,j) - f'(i,j)]^{2} \quad (4)$$

The original image *f (i, j)* and the segmented or reconstructed image *f'(i, j)*. The higher of MSE value refers to the lower image quality.

3.2 Peak Signal – to – Noise Ratio: Bigger SNR and PSNR point out a smaller difference between the original (without noise) and reconstructed or segmented image. This is the most widely used objective image quality/ distortion measure. The most important advantage of this measure is ease of calculation but it does not reflect perceptual quality. The small value of Peak Signal to Noise Ratio (PSNR) means that image is poor quality. PSNR is defined as follow

$$PSNR = 20\log_{10}\left(\frac{1}{RMSE}\right) db \quad (5)$$

*3.3 Structural Content:*The large value of Structural Content (SC) means that image is poor quality. SC is defined as follow:

$$SC = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} x(i,j)^{2}}{\sum_{i=1}^{M}\sum_{j=1}^{N} x(i,j)^{2}} \quad (6)$$

3. 4 Normalized Absolute Error (NAE): The Normalized absolute error can be calculated by

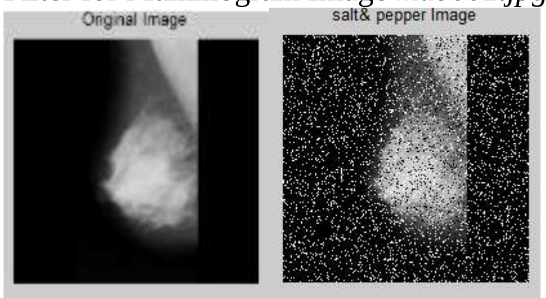
$$NAE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}[|f(i,j).f(i,j)|]}{\sum_{i=1}^{M}\sum_{j=1}^{N}[|f(i,j)|]} \quad (7)$$

NAE is a measure of how far is the reconstructed image from the original image with the value of zero being the perfect fit. Large value of NAE indicates poor quality of the image, small value of NAE gives good quality image.

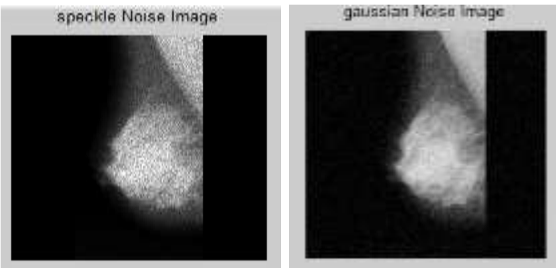
4. Experimental Results and Discussions

The UK research group has generated a MIAS database of digital mammograms. The database contains left and right breast images of 161 patients. Its quantity consists of 322 images, which belongs to three types such as Normal, benign and malignant. The database has been reduced to 200-micron pixel edge, so that all images are with the resolution 1024 x 1024. There are 208 normal, 63 benign and 51 malignant (abnormal) images. It also includes *radiologist's _truth* marking on the locations of any abnormalities that may be present. The database is concluding of four different kinds of abnormalities namely: architectural distortions, suspicious lesions, circumscribed masses and calcifications. The preprocessing step is very important for medical image processing to analyze the breast cancer in mammography images.

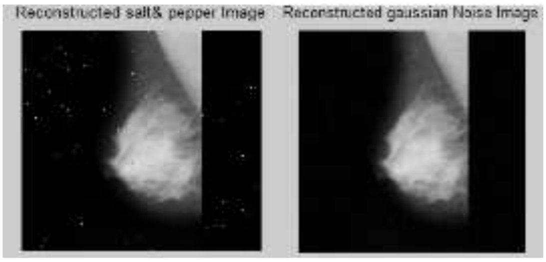
In this paper, four types of filtering techniques are explored for preprocessing with a focus on the parameters: MSE, PSNR, SC and NAE. These parameters are calculated and tabulated as shown in the tables1, .2,. The MSE value is small for adaptive median filter when compared with other three methods; MSE value for adaptive median filter is 6.7584 (mdb001) as shown in table.2. The image quality is good for adaptive median filter. The small value of PSNR means that image is of poor quality. The PSNR for adaptive median filter is 39.8323 (mdb001) shown in table 1, which is very high while compared with other filters. Large value of NAE indicates poor quality of the image, small value of NAE gives good quality image. NAE is 0.0809 (mdb001) for wiener filter while compared with other filters. From these observations, it is concluded that the adaptive median filter is performs bettercompared with the other filters. Figure 2 shows the results of Median Filter for Mammogram Image *mdb001.jpg*.



(a) (b)



(c) (d)



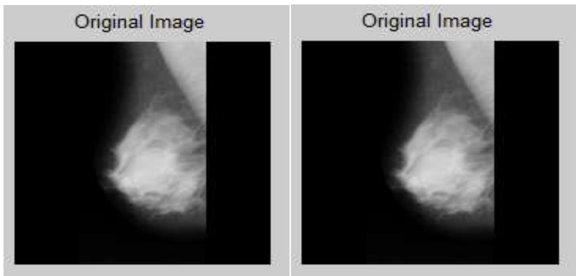
(e) (f)

(g)

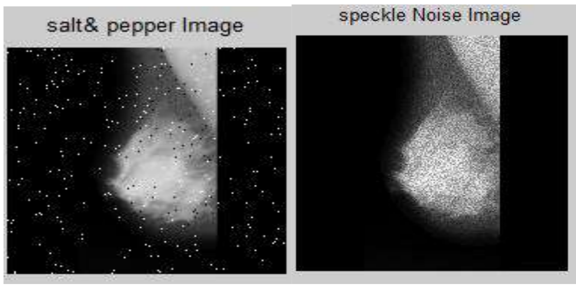
Figure.2 Results of Median Filter for Mammogram Image *mdb001.jpg*
(a)OriginalImage(b) Salt and Pepper noise Image (c)Gaussian noise Image (d) Speckle noise Image, (e) Reconstructed Salt and Pepper Image.(f) Reconstructed GaussianImageand (g) Reconstructed Speckle Image

Table.1 Performance Measures - Median Filter for Mammography Images

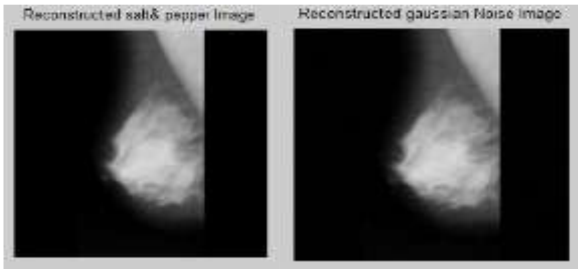
Noise	Image	MSE	PSNR	SC	NAE
Salt&Pep	Mdb001	65.8468	30.5837	0.9905	0.0134
	Mdb155	63.1807	30.1250	0.9945	0.0127
per	Mdb322	52.2811	30.9474	0.9963	0.0088
Gaussian	Mdb001	14.7559	36.4411	0.9960	0.0703
	Mdb155	19.9849	35.1238	0.9977	0.0601
	Mdb322	16.2589	36.0199	0.9976	0.0505
Speckle	Mdb001	29.6909	33.4046	0.9958	0.0606
	Mdb155	42.9881	31.7973	0.9970	0.0611
	Mdb322	53.1396	30.8766	0.9964	0.0604



(a) (b)



(c) (d)



(e) (f)

(g)

Figure.3 Results of Adaptive Median Filter for Mammogram Image *mdb001.jpg*
(a)OriginalImage (b) Salt and Pepper noise Image (c)Gaussian noise Image(d) Speckle noise Image

(e) Reconstructed Salt and Pepper Image (f) Reconstructed Gaussian Imageand (g) Reconstructed Speckle Image.

Table 2 Performance Measures - Adaptive Median Filter for Mammography Images

Noise	Image	MSE	PSNR	SC	NAE
Salt& Pepper	Mdb001	6.7584	39.8323	1.0016	0.0174
	Mdb155	16.4629	35.9657	1.0026	0.0162
	Mdb322	15.9076	36.1147	1.0015	0.0132
Gaussian	Mdb001	8.4131	38.8812	0.9995	0.0366
	Mdb155	16.9375	35.8423	1.0011	0.0329
	Mdb322	13.3343	36.8811	1.0006	0.0261
Speckle	Mdb001	11.2664	37.6126	1.0068	0.0300
	Mdb155	22.6281	34.5843	1.0066	0.0299
	Mdb322	16.3338	35.9999	1.0053	0.0269

5. Conclusion:

Pre-processing stage is an application dependent technique for enhancing the content of medical image based on removal of special markings and speckle noise. Removal of special markings and speckle noise existing in medical images will increase the quality of image segmentation. On the other hand, it will improve the accuracy and efficiency of content based medical image classification and retrieval systems. In this paper, we have presented four types of filtering techniques for pre-processing of mammography images. We have compared the values of performance evaluation parameters such as image quality, mean square error, Peak signal to noise ratio, structural content and normalized absolute error. All the four types of filters are tested for 322 mammogram images(MIAS). From the observations, we conclude that the adaptive median filter is more appropriate method compared to other filters because of better image quality.

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