IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Pre-Processing Techniques For Breast Cancer Detection In Mammography Images

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Abstract: Breast cancer is very common and considered as the second dangerous disease all over the world due to its mortality rate. So, if the detection is early enough, it can reduce the death rate. Image processing techniques are applied to accurately segment the Region of Interest (ROI) prior to abnormality detection in digital mammograms. The digital mammograms can majorly classify into two types, normal and abnormal. Abnormal cases are taken for further process. In this paper, some of the Non-linear techniques are applied to the mammogram images for the removal of noise at pre-processing. Noise removal is done by using lee filter, frost filter, median filter and improved statistical based bilateral filter. The best filter is selected by measures of MSE, PSNR and SSIM. Mammogram from MIAS database is taken for simulation.

IndexTerms **- Mammogram, MIAS dataset, ROI, Median filter, Improved statistical based bilateral filter, MATLAB.**

I. INTRODUCTION

INTRODUCTION

Detection of breast cancer can be achieved using Digital Mammography. The electronic breast images provided by digital mammogram can be enhanced by CAD systems. The difference between regular mammogram and digital mammogram is that a regular mammogram system rely on film. But in digital mammogram, the digital images are viewed and stored on a computer. To remove noises from an mammogram, pre-processing techniques are applied to mammogram images and also smoothening, sharpening the imagers and to remove the contrast of the image, removing blur which occurred during image acquisition by using some filtering techniques. In this paper, lee filter, frost filter, median filter and improved statistical based bilateral filter are used in pre-processing stage.

LITERATURE REVIEW

The pre-processing techniques used by Vibha.S.Vyan and Pritirege (2015) was Gabor filter. The advantage of this filter was uniqueness, it is very much specific toa period and scale. The fourier analysis is fast using FFT in gabor filter, the output of this filter is relevant for quantization of stationary signals. But the disadvantage of this technique was FFT requires the size of the image to be about the power of 2 and there is a problem with a boundary condition.

The pre-processing technique which was used by Dr.A.SriKrishna (2014) was Image Normalization. The advantage of this technique is, if images are normalized before the endorsement and the size and location of the endorsements would be consistent among different pages in the dataset and if images are printed, using normalized images would prevent printing problems due to changes in page size and orientation. But the problem faced by this technique is, the image normalization can be a time-consuming process and can add a significant amount of time to the e-Discovery export process in large cases and using poorly designed normalization software can result in degradation of overall image quality.

The histogram equalization technique used by M.Aarthy and P.Sumathy (2013) was simple and enhance contrasts of an image. But the disadvantage of this technique is, if there are gray values that are physically far apart from each other in the image, then this method fails.

The pre-processing technique used by Junn Shan Wenju et.al, (2014) was mean filter. The main advantage of this filter is the variance is reduced. But the problem is the impulse noise is not completely removed and the mean value of all pixels in neighborhood are affected.

II. PRE-PROCESSING TECHNIQUES

Pre-processing techniques are used in the digital mammogram images to remove noises from the images by using filtering techniques. So, the noise removal is done by using lee filter, frost filter, median filter, and improved statistical based bilateral filter. The best filter is selected by measures of MSE, PSNR and SSIM.

2.1 Lee filter

The Lee filter operates by considering a local neighborhood around each pixel and replacing the pixel value with a weighted average of the intensities within that neighborhood. The weights are determined based on statistical characteristics of the neighborhood, such as the mean and variance. The mathematical expression for lee filter is given as,

$$Y(i,j) = \bar{k} + W * (C - \bar{k}) \quad (1)$$

Where, Y(i,j) is filtered image

$\bar{k}$ is the mean of the kernel/window

W is the weighing function

C is the center element in the kernel/window

To calculate W:

$$W = \frac{\sigma_k^2}{\sigma_k^2+\sigma^2} \quad (2)$$

Where, σ^2 is the variance of the reference image

σ_k^2 is the variance of the pixels in the kernel/window of the speckled noise.

2.2 Frost filter

In image processing, the Frost filter, also known as the Frost adaptive filter, is a spatial domain filter used for speckle noise reduction. Unlike the Lee filter, which estimates local statistics using the mean and variance, the Frost filter employs a more robust statistical estimator called the local geometric mean. The local geometric mean estimates the center of the probability distribution of pixel values within the neighborhood, which helps in differentiating between noise and actual image features.

Based on the local statistics in a sliding window, the frost filter works on preserving the edges while suppressing the noise. The Damping factor which is an exponential damping is the key factor in controlling the smoothness of the filter. When damping factor is small, the image tends to be smooth. Here the damping factor is assumed as 1. The mathematical expression for frost filter is given as,

$$Y(i,j) = \frac{\sum_{i,j=256}(x(i,j)*W}{\sum W} \quad (3)$$

Where, x is the pixel values in the local window

Y is the filtered pixel values in the local window

W is the weight for each pixel in the local window

2.3 Median filter

Median filter is one type of non-linear digital filtering technique which is used to remove noises from an image. This filter is useful as it can preserve sharp features from an image whilst filtering noise. One of advantages of this filter is more robust average than the mean and so it does not affect the median value significantly.

Consumer Price Index (CPI) is used as a proxy in this study for inflation rate. CPI is a wide basic measure to computeusualvariation in prices of goods and services throughout a particular time period. It is assumed that arise in inflation is inversely associated to security prices because Inflation is at lastturned into nominal interest rate andchange in nominal interest rates caused change in discount rate so discount rate increase due to increase in inflation rate and increase in discount rateleads todecreasethe cash flow's present value (Jecheche, 2010). The purchasing power of money decreased due to inflation, and due to which the investors demand high rate of return, and the prices decreased with increase in required rate of return (Iqbal et al, 2010).

2.4 Improved statistical based bilateral filter

In the previous approaches, for speckle noise filtering, homomorphic techniques consider the global statistics for filtering. So this techniques does not preserve edges. The available adaptive filters consider the correlation property of the speckle noise in the filtering process. But the adaptive filters might wrongly interpret speckle as fine edge and fine edge as speckle in the process of filtering which leads to improper speckle reduction and blurring respectively.

The bilateral filter is efficient as it considers the structural details in addition to intensity levels and adjacent similarities of the neighbourhood pixels for filtering. But it failed to include the speckle noise variation level in the filtering process. In the noisy image, the speckle noise variance influences the level of loss in the structural details. If the speckle variance is high in the noisy image, it consists of lesser edge details. Otherwise the edge details may be more.

In the proposed technique, coefficient of speckle variation v is used to find the local statistics of the image. Based on the value of v, bilateral filter is applied to every input pixel. If the value of v is 0, it indicates higher speckle noise and the bilateral filter is applied. If the value of v is equal to 1 then it indicates less speckle noise level and the pixel in the input is retained.

$$v(i,j) = 1 - \frac{k_u{}^2}{k_s{}^2} \quad (4)$$

Where, $k_u{}^2$ is speckle noise variance and $k_s{}^2$ is image pixel variance.

III. RESULTS AND DISCUSSIONS

The Result of Preprocessing is shown in Figure 4.2(b). As compared with the original image (Figure 4.2a), the filtered images have low noise.

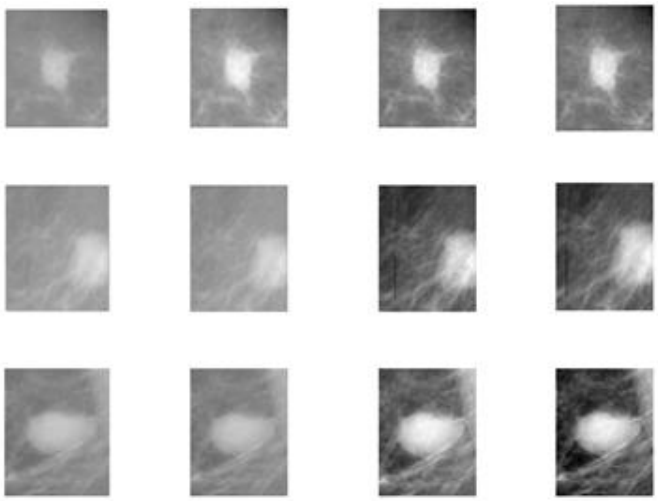

Fig. 1 Output images of Lee filter, Frost filter, Median filter and Improved statistical based bilateral filter

TABLE 1

Performance evaluation of pre-processing

Pre-processing techniques	Quality measurement values	 Original image 1	 Original image 2	 Original image 3	 Original image 4
Lee filter	MSE	5.26	6.43	5.26	5.83
	PSNR	36.516	40.0788	40.9484	39.354
	SSIM	0.4601	0.4580	0.4508	0.528
Frost filter	MSE	4.08	4.19	4.64	4.61
	PSNR	41.741	43.1152	42.6679	42.768
	SSIM	0.75	0.762	0.6490	0.735
Median filter	MSE	3.89	3.58	3.72	3.14
	PSNR	43.625	45.528	44.273	46.249
	SSIM	0.82	0.805	0.798	0.836
Improved statistical based Bilateral filter	MSE	1.78	1.68	1.2431	1.35
	PSNR	52.345	53.284	51.628	53.192
	SSIM	0.96	0.9826	0.9841	0.973

IV. DATASET AND SOFTWARE TOOL USED

TABLE 2. Materials and Methods

Description	Specification/ numbers
Dataset	MIAS and DDSM
Number of Mammograms	4095
Tools used	MATLAB R2023b

V. RESULTS AND DISCUSSIONS

The proposed methods were applied on different digital mammograms and some results are given below. Each figure indicates the original image, output image of Lee filter, Frost filter, Median filter and Improved statistical based bilateral filter. By comparison of these four pre-processing techniques, Improved statistical based bilateral filter provides better results with low MSE, high PSNR and SSIM values.

VI. CONCLUSION

In the field of medical images, various noises are added in the original image. The noises are removed by using various image filtering techniques. In this paper, the main aim is to remove the detected masses from the original images by using some

pre-processing techniques. By comparison of these non-liner filters, Improved statistical based bilateral filter provides better results with low MSE, high PSNR and SSIM values.

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AVAILABILITY OF DATA AND MATERIALS

Not applicable.

ACKNOWLEDGEMENTS

Not applicable.

FUNDING

Not applicable.

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ETHICS DECLARATIONS:

Ethics approval and consent to participate:

Not applicable.

Consent for publication:

Not applicable.

Competing interests:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.