Pre-Processing Techniques for Digital Mammograms

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Abstract: ***Breast cancer is very common disease all over the world due to its death rate especially to women's. if the detection is early enough, it can reduce the mortality rate. Detection of breast cancer can be done by using digital mammography. The initial and fundamental step for breast cancer detection in image processing is pre-processing. In this paper, some of the pre-processing techniques are proposed and the results are compared with the existing preprocessing techniques. Average Value Padding AMF is the proposed filter used to minimize the edge distortion due to zero padding. The existing Haar transform, median filter and adaptive median filters are considered for the comparison of performance evaluation. The proposed method is is better in terms of f MSE (mean square error), PSNR (peak signal to noise ratio) and SSIM (structural similarity index measure) values. MIAS and DDSM dataset are taken for experimental purpose.***

Keywords: Mammogram, Haar transform, Median filter, Adaptive median filter, AV padding AMF, PSNR, MSE, SSIM

1. Introduction

A process of X-ray examination of medical images is digital mammogram. CAD systems is used to enhance the electronic breast images provided by digital mammogram. The regular mammograms are rely on film. In digital mammogram, the images are viewed and stored in computer. Because of this, it can also easier to view and manipulate the images in 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, haar transform, median and adaptive median filter.

2. 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.

3. Pre-Processing Techniques

The main objective of pre-processing technique is to improve or enhance the quality of image data that removes unwanted noises or to boost some image features that are important for further processing. These all are done by using the following techniques,

a) Haar transform
b) Median filter
c) Adaptive median filter

a) Haar Transform:

Haar wavelet compression is an efficient way to perform both lossless and lossy image compression. It relies on averaging and differencing values in an image matrix to produce a matrix which is sparse or nearly sparse. A sparse matrix is a matrix in which a large portion of its entries are 0.The output of haar transform is given by,

$$O(p,q) = haart2(I(p,q),2);$$

Where, I (p,q) represents the original image and O (p,q) represents the output image and nxn is the size of an image.

b) Median Filter

A median filter is a nonlinear filter in which each output sample is computed as the median value of the input samples under the window – that is, the result is the middle value after the input values have been sorted. Ordinarily, an odd number of taps is used. The output of median filter is given by,

O (p,q) = medfilt2 {I (p-i , q-j), i,j € M}

Where, I (p,q) represents the original image and O (p,q) represents the output image. M is the dimensions of the mask and the size is m x m.

c) Adaptive Median Filter:

The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by impulse noise. The Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbor pixels. For each pixel in the image, calculates the median value in a surrounding neighborhood of the pixel and compares the median with a threshold and decides to either replace the pixel, keep the pixel or increase the neighborhood size and recalculate. It only affects the image pixels to determine whether the image have noise content or not. This adaptive median filter performs well for low or high noise densities.

d) AV Padding Adaptive Median Filter (AV Padding AMF)

Improved adaptive median filtering technique, proposed as AV padding adaptive median filtering is used for preprocessing stage which reduces the impulse or salt and pepper noise in turn enhances the classification accuracy.

Algorithm of the proposed av padding adaptive median filter:

Step 1: Convert the image in to normalized grey scale image using linear normalization using,

$$I_N = (I - \min)\left(\frac{newmax - newmin}{max - min} + newmin\right) \quad (4.2)$$

where, new max = 255 and new min= 0.

For example, if the intensity range of the image is 50 to 180 and the desired range is 0 to 255 the process entails subtracting 50 from each of pixel intensity, making the range 0 to 130. Then each pixel intensity is multiplied by 255/130, making the range 0 to 255. The median filter is a nonlinear statistical filter that replaces the current pixel value with the median value of pixels in the neighboring region. Some boundary pixels are distorted due to zero padding effect.

In order to overcome the drawback, in the proposed filtering technique, the padding is done by taking average values of the pixels in the kernel and the average value is padded in the edges. This is done for the top and bottom row pixels and the left most and right most column of the kernel.

Step 2: AV padding for reducing the boundary distortion 3 x 3 median filter kernel is used.

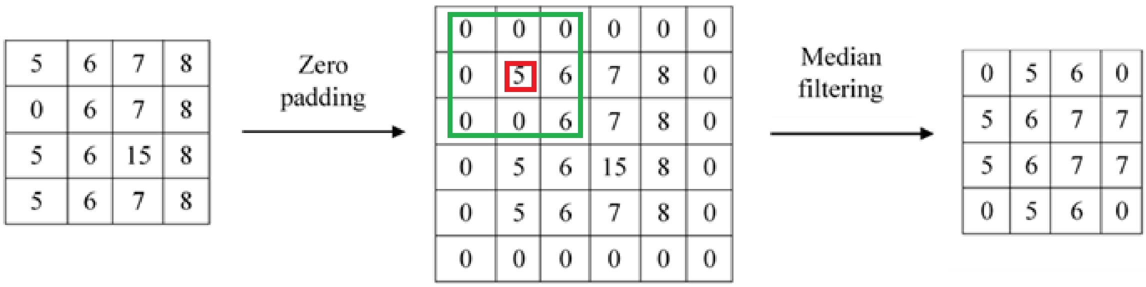
The 3 × 3 kernel requires padding 3/2 = 1 column of average values at the left and right edges while 3/2 = 1 row of average values at the upper and bottom edges.

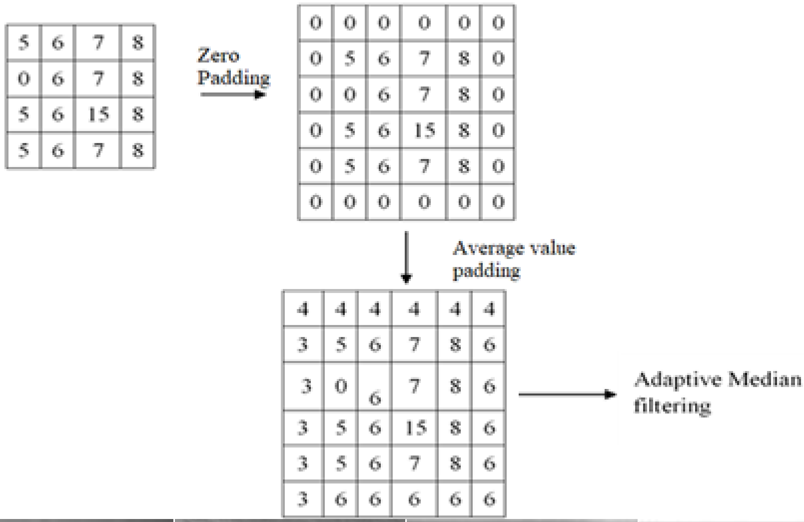
After the padding of average values, the Adaptive Median filter algorithm explained in the section 3.3.1 is used to preprocess the images.

A 4x4 grayscale image is given by,

5	6	7	8
0	6	7	8
5	6	15	8
5	6	7	8

Filter the image with a 3x3 median filter, after zero-padding. Filter the image with a 3x3 adaptive median filter, after average padding at the image borders.





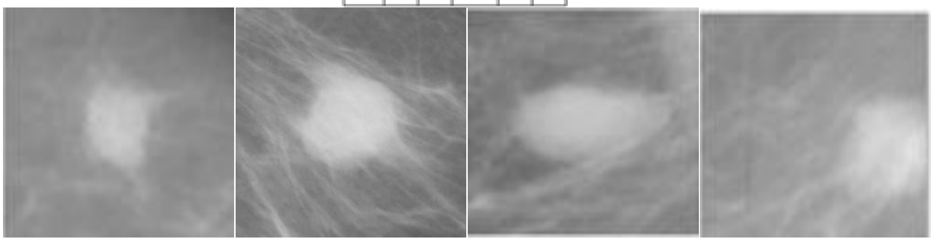


Figure 4.2(a) Original images

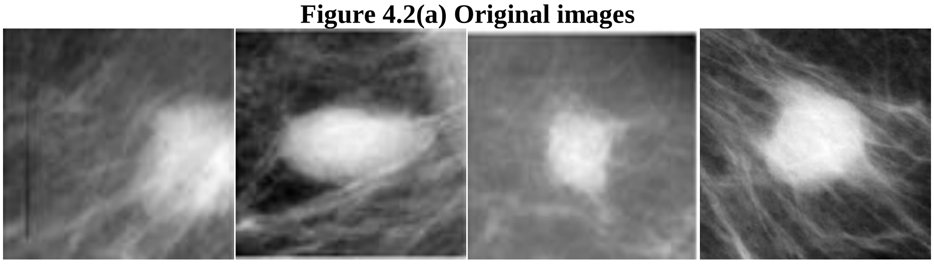


Figure 4.2 (b): AV padding adaptive median filtered images

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.

4. Dataset and Software Tool Used

Table I: Materials and Methods

Description	Specification/ numbers
Dataset	MIAS and DDSM
Number of Mammograms	4095
Tools used	MATLAB R2019a

5. 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 haar transform, median filter and adaptive median filter. By comparison of these three pre-processing techniques, AV padding adaptive median filter provides better results with low MSE, high PSNR and SSIM values.

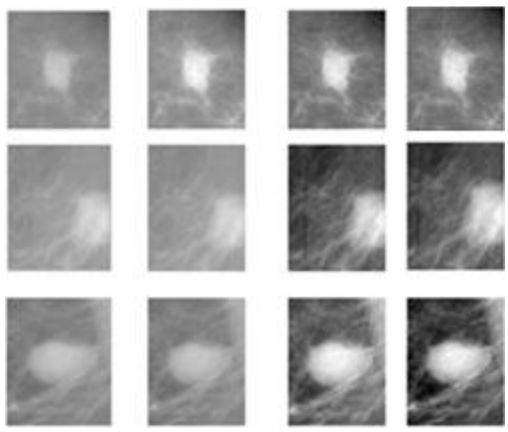
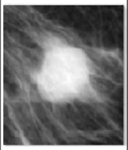
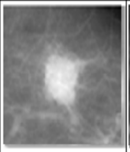
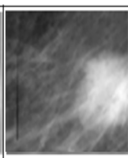
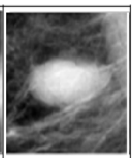


Figure 1: Original images and output images of haar transform, adaptive median and AV padding adaptive median filter

Table 2: Comparison table of MSE, PSNR and SSIM values for various images

Pre-processing techniques	Quality measurement values	 Image 1	 Image 2	 Image 3	 Image 4
Haar transform	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
Median 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
Adaptive 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
AV Padding Adaptive median filter	MSE	2.64	3.04	2.65	2.18
	PSNR	48.9718	48.9903	47.2868	49.65
	SSIM	0.89	0.84	0.87	0.89

6. 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, AV padding adaptive median filter provides better results with low MSE, high PSNR and SSIM values.

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