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Breast Cancer Image Enhancement using Median Filter and CLAHE

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Abstract— Breat cancer is one of the major causes of death for woman in world wide. Mammography is the basic screening technique for early detection of tomour in the breast. The major objective of mammography is to detecting the small lumps at an earliest because they may lead for cancer. But it is difficult to identify the very small tomours in the conventional mammography because they are very noisy, low contrast, blur and fuzzy kind of images, it is necessary to enhance the mammography. Enhancement is done to bring out specific features of the mammography such as mass and microcalcification and to heighlight certain characteristics for early detection and easy diagnosis of breast cancer. This paper comprises the different denoising and cintrast enhancement techniques to recognize the suitable enhancement technique for mammography. Mammograms are denoised by linear and nonlinear filtering techniques and efficiency is measured by Root Meam Square Error (RMSE) and Peak Signal to Noise Ratio (PSNR) and then contrast of the image is enhanced by histogram based techniques.

Index Terms— Breast Cancer, Mammography, Denoising, Contrast enhancement, Root Mean Square Error (RMSE), Peak Signal to Noise Ratio (PSNR), Contrast-Limited Adaptive Histogram Equalization (CLAHE).

1 INTRODUCTION

Breast cancer is a major health problem for women. Mammography is basic screening method for early detection of cancer. In conventional mammography tumours are not properly visible. A tumor can be of two types benign or malignant. In benign tumors the cells are normal in appearance but it is not cancerous, the cells will grow slowly but it does not spread to other parts of the body [2], [3], [4]. But malignant tumors can spread to other parts of the body and it is cancerous. The most challenging area in medical imaging is mammography. In mammography the low energy X-rays is used to create images and to examine the human breast and thus it helps to detect the breast cancer at the early stage by detecting the small calcium deposits. In this sense, an image enhancement plays an important role to reduce the noise level of the image, preserving important details and enhancing the contract to improve the detection of mammographic features. Several denoising methods based on linear and nonlinear filters have been introduced to reduce the noise level [17-25]. In this paper filters considered are: average, median, minmax, winer filters based on the independent component analysis of the image [5], [6]. The proposed system consists of two main steps including denoising image and contrast enhancement. To evaluate this method, 20 images of mini-MIAS database [16] of mammograms are used.

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2 LITRETURE REVIEW

Lot of work has been done in the past for the enhancement of mammograms. The contrast enhancement of mammograms for rapid detection of microcalcification clusters method consisted image scaling, breast region segmentation, noise cancellation using a filter, which is sensitive to microcalsifications and contrast enhancement of mammograms using Contrast-Limited Adaptive Histogram Equalization (CLAHE) and wavelet transform [3]. The literatures review on some of the image enhancement techniques for enhancing digital mammograms. Various spatial and frequency domain techniques were discussed [4]. In [2] a comparative study in digital mammography image enhancement algorithms such as wavelet-based enhancement, CLAHE, morphological operators and unsharp masking were presented. An optimal adaptive neighborhood processing algorithm with a set of contrast enhancement functions to enhance the mammographic features were discussed. The method can enhance the desired, but unseen or barely seen features of an image with little enhancement of the noise and other background variations [6]. Algorithms for both local contrast enhancement and background texture suppression in digital mammography images [7], [21]. The dual-tree complex wavelet transform overcomes the limitations of linear filtering techniques- it is nearly shift-invariant and is oriented in 2D [8].

3. METHODOLOGY

The mammography image enhancement technique is done in two ways. First denoising image by using average, median, and winer filter. Second contrast enhancement using histogram based techniques.

3.1 Removing the Noise

The basic enhancement needed in mammography is denoising, especially for dense breasts. Normally

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mammography image can be filtered by using linear filtering and nonlinear filtering techniques and also spatial and frequency domain filtering techniques.

3.1.1 Median Filter

A median filter is nonlinear type of filter and efficient to remove of salt and pepper noise and Gaussian noise. It helps to keep the sharpness of the image at the time of removing the noise. Potency of median filter depends on the scale of the windowing [13]. For mammography 3X3 window provides smart result. In median filter, the value of an output component is determined by the median of the neighborhood pixels as shown in the figure 1. The median is good to evaluate extreme values and so better able to take away this outlier without reducing the sharpness of the image.

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Neighbourhood values are
115,119,120,123, 124
125, 126, 127, 150

Median is 124

Fig. 1 Median value of a local pixel neighborhood in 3X3 window mask.

3.1.2 Max and Min filter:

The median filter is order statistics filter most used in image processing. The minimum and maximum intensity values of all the elements inside a windowed region. If the intensity of the central element lies inside the intensity vary unfold of its neighbors, it is passed on to the output image with out changing the intensity. However, if the central element intensity is larger than the utmost worth, it is s set up to the utmost maximum value; if the central element intensity is a smaller amount than the minimum value, it is set up to the minimum value. Max filter, is given by the equation *f(x, y)=max{g(s, t)} (s, t)€ Sxy*. The *0th* percentile filter is the min filter. *f(x,y)=min{g(s,t)} (s, t)€ Sxy* This filter is useful for finding the darkest and brightest points in an image as shown in figure 2.

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Neighbourhood values are
115,119,120,123, 124
125, 126, 127, 150

Min=115 and Max=127

Fig. 2 smoothing a local pixel neighborhood in minmax filters for central value 150

3.1.3 Wiener Filter:

The wiener filter is a type of linear filter which is applied to an image adaptively, designing itself to local image variance. If the varience is large then it performs little smoothing. If the variance is small, it performs smoothing is better with preserving edges and other details [1]. The winer is frequency domain filter. It works better for Gaussian noise. It can be achived with the following equations.

$$X'(k,l) = G(k,l)Y(k,l) \quad (1)$$

G(k,l) is minimum value

$$E[|X(k,l) - G(k,l)Y(k,l)|^2] \quad (2)$$

Both noise and signal are random process and independent to one another. Hence the minimized expression is

$$G(k,l) = \frac{H(k,l)}{\left\{|H(k,l)|^2 + \frac{Su(k,l)}{Sx(k,l)}\right\}} \quad (3)$$

Where Sx is signal power spectrum and Su is noise power spectrum.

3.2 Contrast Enhancement

3.2.1 Histogram Equalization

This method is most useful for medical image applications because it helps to increase the contrast globally especially when the interested area and background are represented by close contrast values. By this method the intensities can better distributed on the histogram which allows getting better contrast of the image. In this particular application it leads to better views of breast part from the background. The histogram equalization is achieved by using equation 4.

$$H(V) = ROUND\left(\frac{CDF(V)-CDFMIN}{(MxN)-CDFMIN}\right)X(L-1) \quad 4)$$

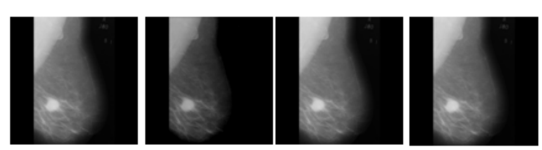
Where the cdfmin is minimum value of cumulative frequency distribution and MxN is size and L is gray level.

3.2.2 Contrast Limited Adaptive Histogram Equalization (CLAHE)

The CLAHE algorithm is a widely used technique which results in contrast enhancement of medical images. The histogram is cut at some threshold and then equalization is applied. It is adaptive contrast histogram equalization method [7-10], where the contrast of an image is enhanced by applying CLAHE on small data regions called tiles rather than the entire image. The resulting neighboring tiles are then stitched back seamlessly using bilinear interpolation. The contrast in the homogeneous region can be limited so that noise amplification can be avoided [15].

4 Experimental Results

Among all the techniques discussed above the weiner filter gives low RMSE and high PSNR as shown in the following figure 3.



(a) (b) (c) (d)

Fig. 3: Result of denoising Mammography (a) Original image (b) Minmax filter (c) Median filter (d) Winear filter

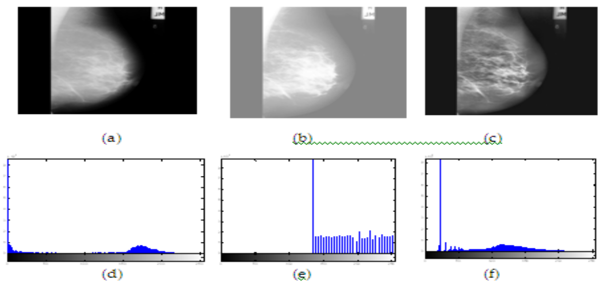


Fig. 4: Results of Contrast enhancement (a) Original Image, (b) Histogram equalization, (c) CLAHE (d) Histogram of (a), (e) Histogram of (b) and (f) Histogram of (c).

As shown in the above figure 4 explains the representations of histogram methodology. The figure 4 (a) the histogram representation is low contrast and (b) is indicator for brightest image and (c)

4. Result Analysis And Discussion

To measure the analysis of the filtering techniques, the image quality measures such as RMSE and PSNR is used. The Table1 values are RMSE values, the winer filter gives minimum RMSE values and Maximum PSNR as shown in the table 2. The same PSNR and RMSE are represented with line graph, the dashed a line indicates the efficient techniques at the figure

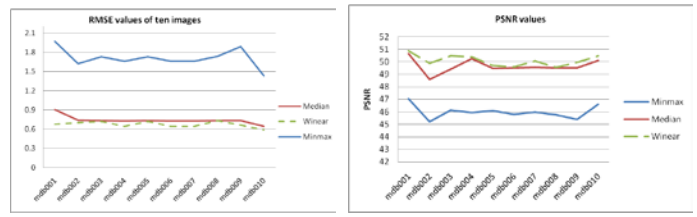
TABLE 1
RMSE values of ten images of Mini-MIAS database

	Minmax	Median	Winear
mdb001	1.9722	0.9065	0.6726
mdb002	1.6189	0.7394	0.6997
mdb003	1.7261	0.7297	0.7212
mdb004	1.6573	0.7257	0.6436
mdb005	1.7261	0.7297	0.7212
mdb006	1.6573	0.7257	0.6436
mdb007	1.6573	0.7257	0.6436
mdb008	1.7353	0.7303	0.7294
mdb009	1.8864	0.7336	0.6633
mdb010	1.4315	0.641	0.586

TABLE 2
PSNR values of ten images of Mini-MIAS database

	Minmax	Median	Winear
mdb001	47.0563	50.6739	50.8783
mdb002	45.2154	48.591	49.887
mdb003	46.1332	49.4012	50.4873
mdb004	45.9442	50.2604	50.4031
mdb005	46.0727	49.4759	49.7156
mdb006	45.7941	49.5331	49.5845
mdb007	45.9709	49.5573	50.0783
mdb008	45.7711	49.5295	49.5352
mdb009	45.4086	49.5099	49.9475
mdb010	46.6068	50.0961	50.4855

3 and 4.



(a) (b)

Fig. 5: Results of different filtering techniques (a) RMSE values ploted (b) PSNR values ploted and line indicate the efficient denoising technique.

This illustrates the denoising capability of winer filter is the most effective, and as shown in the figure 5(a) and (b). The CLAHE is efficient technique for contrast enhancement.

6 Conclusion

Presently the breast cancer leading for death of middle age women. Most of the doctors suggest mammography as basic test for diagnosis of breast cancer. In this paper the low contrast, nosy and blur images are enhanced by using different filtering techniques and contrast enhancement techniques. Winer filter is suitable for denoising the image and CLAHE is good for increase the contrast of the image. These methods help to doctors and radiologist for correct diagnosis of the desieses at an earliest.

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