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Effective Filtering Algorithms for Enhancing Mammogram Images

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Abstract: Image filtering algorithm are done on the mammogram images for removing various types of noises which are present on the images during capturing or viewing into the images during diagnosis. Mammogram images when observed usually have various noises such as Gaussian noise, salt and pepper noise and speckle noise. In this paper, various types of image filtering algorithm are performed for three various noise types. The performance analysis of the filters is compared using peak signal to noise ratio (PSNR) and mean square error (MSE). The modified filters provide the desirable result evaluation by using above two parameters to the three different noises. Finally mammogram images are analyzed using different filtering algorithm for the removal of noises present.

Keywords: Gaussian noise, salt and pepper noise, speckle noise, peak signal to noise ratio and mean square error.

I. INTRODUCTION

Breast cancer is one of the major causes which increase the mortality among women, especially among the rural area and urban area. Breast cancer that affects more women in urban area than the rural area. Detection of earlier breast cancer and subtle signs of breast cancer requires high quality images and skilled mammography interpretation. In order, for the detection breast cancer early, we need high quality images. Mammography screening methods have to be effective in decreasing breast cancer mortality through the detection, hence the treatment of early onset of breast cancer. The diagnostic values for decreasing the percentage of immunoglobulin G1 (%IgG1) in breast cancer were analyzed with special emphasis among the early tumor stages. An early clinical diagnosis and appropriate treatment have to be preventing which would reduce this high mortality. The most widely method used for diagnosis is mammography, breast radiography under controlled conditions. The condition to perform the breast mammography is to transversal the plane on X-ray beams, which falls on the film, parallel to the breast.

The radiography is to be observed for seeking microcalcifications clusters because it have an important sign of possible formation of cancer. Size of micro calcifications is very close for the resolution limits to the system, thus it becomes important to improve image quality. Diagnosis interpretation becomes difficult due to the effects of degradation and limits of resolution. One approach to this problem leads to an automatic detection method of micro calcifications on digitized images. The method of comparison with the texture of mammographic images for achieving better contrast for the microcalcifications. This is performed by lowering the level of grey of a matrix that should have to be adjusted according to the associated histogram. This procedure gives a good result, but it reduces grey levels images, which means that the image loses part of the information, but gains in computational time.

This paper deals with four common filtering algorithms for mammogram images for three different noise types. The simulation is performed by using matlab 7.1 versions. The organization of these papers is as follows: Section 2 is explains the methods of filter, Section 3 describe about the Experiment as results and evaluation and Finally Section 4 provides conclusion.

II. FILTERING METHODS

Most images are affected by mixing with some extent of noise, which can't be defined in the variation on data gets disturbances by the image intensity that are either uninterruptable or without interest. Image analysis is often simpler, if these noises have to be filtered out. The term filter is to deals with the operations of accentuate features with the interest in data. Image filters would be used to emphasize edges that is, boundaries in between the objects or parts of objects in the images. A filter provides the way to visual interpretation of images, and can also be used as a precursor to further digital processing, such as segmentation.

A filter reevaluates the value of each pixels of an image. For particular pixels, the new value is based on the pixel values near the local neighborhood, a window centralized on that pixel, in order to define and perform the operation to the following. They are, 1. Reduce noise by smoothing, and/or 2. Enhance edges. Filters are linear in their operation if the outputs values are linear combinations of the pixels on the original image, if not they are nonlinear. Linear filters are good in understanding and very quick to compute, but are not capable of smoothing without simultaneously blurring edges. Nonlinear filters can smooth without blurring edges and can perform the job of detecting the edges at all orientations simultaneously, but have low in securing the theoretical value foundations and to be slow in computation.

Filtering Schemes

The mammogram image is given as the input to all the filters such as mean, adaptive, Gaussian and median filters. Let assume the two dimensional sequence {x}, representing the values of the image in m rows and n columns.

$x(p,q) = y(p,q) + n(p,q)$ ------------ (1)

where $p = 1,2,\ldots,i$ and $q = 1,2,\ldots,j$ and $n(p, q)$ is noise.

A. Mean filter

Mean filter or average filter is defined as windowed filter for the linear class, which helps in smoothing the image. The filter performed in as low-pass one. The basic idea includes the filters with any type of element to the mammogram images have to place the averaging across to its neighborhood.

Mean filter or average filter algorithm,

1. Place a window over an element.
2. To find an average through summing up the elements and then divides the sum by the number of elements.

The fundamental and the simplest way of these algorithms is the Mean Filter as explained in the equation (1). The Mean Filter is a linear filter that uses a mask over each of the pixel in the images. Every part of the pixels which falls beneath the mask are averaged each other to form a single pixel. This filter is also called as average filter. The Mean Filter is poor in edge preserving. The Mean filter is defined by

Mean filter (x_1 ….. x_N) = Σi N xi =1 ---------- (2)

Where (x_1 ….. x_N) is the image pixel range. Generally linear filters are used for noise suppression. It gives minimum PSNR when compared to non linear filters, which has to be generally maximum hence for mammogram images non linear filters are taken for comparison.

Advantages

1. Finds the most accurate average of the set of numbers.
2. Outliers can change the mean a lot... making it much lower/higher than it should be.
3. All the data is used to find the answer.

B. Adaptive Filter

An adaptive filter is one among the nonlinear device, which their knowledge it is not dealing with the principle of superposition. An adaptive filter processed on the methods of which gives the methods to the adaptive control through which the adjustable set of parameters that are to be used in the filtering process For stationary inputs, the performed operation with solutions are commonly known as the Wiener filter, which is referred to be an optimal values in the mean-square sense. A plotting graph of the mean-square values along with the error signal and the adjustable parameters of a linear filter is termed to be as the error-performance surface. The minimum point of those surfaces represents the Wiener solution.

The Wiener filter is not adequate in dealing with those situations in which the plot are to be inbuilt with the non-stationary of the images and or noise is intrinsic to the problem. The design structure of a Wiener filter needs a priori information of the statistics on the data to be processed. The filter is optimal only when the statistics characteristically terms with the input data that match with a priori information on which the design of the filter is depended. When these collections of information are not well known perfectly, then it cannot be possible for designing the Wiener filter. The calculating sequences of the Wiener filter coefficients provide the autocorrelation matrix of the input signal and the cross correlation vector of the input and the desired signals. The optimum w value is defined by

$$wo = Ryy-1 \ ryx$$

Advantages

1. Provide mechanism for the adaptive control.
2. Optimal in the mean-square sense.
3. Statistics of the data is calculated accurately.

C. Gaussian filter

A Gaussian filter is a filter whose impulse response have to be perform by the operation of Gaussian function. Gaussian filters have the properties such as that cannot be no longer without the overshoot of a step function input since reducing the rises and falls time. These behavior are very nearer to be connected with the facts that makes the Gaussian filter to minimum the possible group delay. The Gaussian filter is non-causal that defines the filter window are symmetric in nature above the origin of the time-domain. These forms the Gaussian filter physically unrealizable and are usually of no consequence to the applications from where the filter bandwidth is much greater to the signal. In real-time systems, a delay incurs because incoming samples are needed to fill the filter window before the filter is to be applied to the signal.

Advantages

1. No amount of delay that helps to make a Gaussian filter causal, because the Gaussian functions are never zero.
2. Focal element receives the heaviest weights which consist of having the highest Gaussian value that deals with the neighborhood elements receives the smaller weights of their distance with the focal element value increases.

D. Median filter

It is nonlinear digital filtering technique, used to remove noise. The pixels are replaced with the median magnitude. The Median Filter has an advantage over the Mean filter, the median of the data is taken rather than of the mean of image. To replace the pixel with the median magnitude. The median of a set is more robust with the presence of noise.

The median filter is given by,

$(x1....xN)$ =Median (||x1||2…….||xN||2) The Simple Median Filter, an original and the filtered pixel having the same pixel. A pixel that does not change through filtering is known as the root of the mask.

The three steps to perform are,

1. Compute the image storing partial derivatives in x (Dx(x, y)) by applying the right 3 × 3 kernel to the original input image.
2. Compute the image storing partial derivatives in y (Dy(x, y)) by applying the left 3 × 3 kernel to the original input image.
3. Compute the gradient magnitude value of S(x, y) based on Dx and Dy.

Advantages

1. Reduce systematic estimation errors in optical flow estimation.
2. Larger schemes with even higher accuracy.
3. Extended optical flow estimation and investigated for transparent motion estimation.
4. Better they approximate Derivative of Gaussian filters.

III. EXPERIMENTAL SETUP AND EVALUATION

To test the accuracy on the Filtering algorithms, three steps are followed.

1. First an uncorrupted mammogram image is taken as input.
2. Second different noises are added to the mammogram image artificially.
3. Third, the filtering algorithms are applied for reconstruction of mammogram images.

To estimate the qualities for the reconstructed image, the values of Mean Squared Error and Peak Signal to Noise Ratio are analyzed for both the original and the reconstructed images. The Performances of various filters are tested with three different types of noise models for the finding the values of Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). The values are analyzed by calculating with the following expressions:

PSNR=10*log10 (256^2/MSE)

Where MSE represents the mean square error of the estimation. The size of the image taken is 256X256 pixels.

The performance analysis are done by using matlab 10 version for Gaussian noise, salt and pepper noise and speckle noise.

- For each of images, different noise models are added artificially in the ratio 0.5.
- Next the different filtering algorithm is applied for each image with various noise models.
- The two parameters such as PSNR and MSE values are calculated to the noise free image and noisy image.

Fig 1- PSNR and MSE for Impulse noise

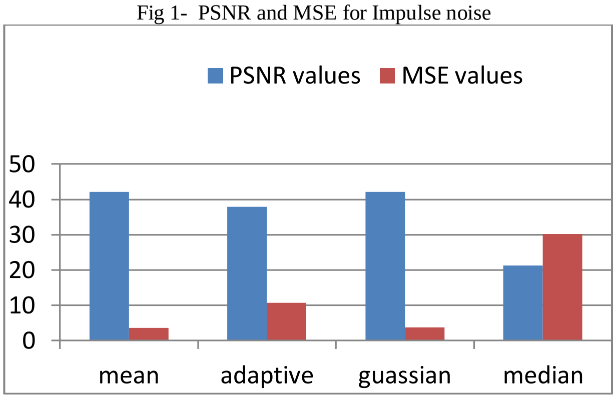

Fig 2- PSNR and MSE for Gaussian noise

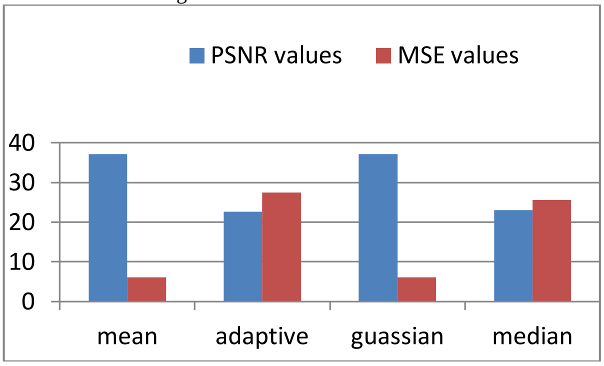

Fig 3- PSNR and MSE for Speckle noise

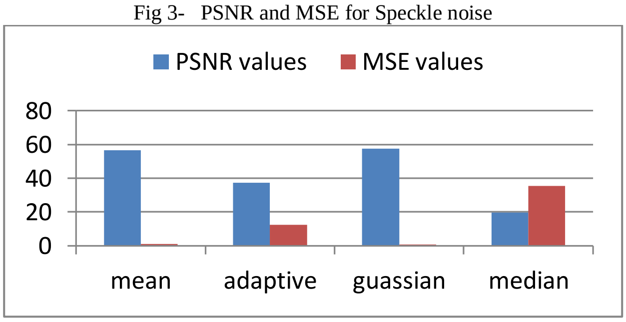

Table .1 - comparison of filters using noise value to determine PSNR and MSE

Methods	PSNR values	MSE values	Noise types
Mean filter	42.1601	3.5861	Impulse noise
	37.0916	6.0510	Gaussian noise
	56.5508	0.8854	Speckle noise
Adaptive filter	37.8603	10.6427	Impulse noise
	22.6586	27.4750	Gaussian noise
	37.2064	12.3719	Speckle noise
Gaussian filter	42.1012	3.6963	Impulse noise
	37.1645	6.1530	Gaussian noise
	57.4501	0.8125	Speckle noise
Median filter	40.3460	3.1644	Impulse noise
	32.0052	5.5526	Gaussian noise
	56.7453	0.8207	Speckle noise

The table.1 shows the comparison of four filters. The MSMF median type filters gives as the better performance than all the other type of filters. It has been clearly noted that the salt & pepper noise is completely removed when compare to other two noise types. It is performed and proved that Gaussian noises are removed worst than other two noise types.

IV. CONCLUSION

In this paper image filtering algorithms are performed on images to remove the different types of noise which either present in the image during capturing the image. In this work, four different image filtering algorithms are compared with the three different noise types. The performances of the filters are analyzed using the Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). All the filters provides the desirable results in terms of an above two parameters for the three different noise types.

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