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PREPROCESSING FILTERS FOR MAMMOGRAM IMAGES: A REVIEW

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Abstract- Breast cancer is a standout amongst the most widely recognized kind of growth among ladies that develops from breast tissue. Still the exact cause of the breast cancer remain unknown. Early detection and diagnosis is the best and most effective strategy to control the tumor progression. Mammography is the currently recommended imaging method for early determination and diagnosis of breast malignancy. A mammogram can identify abnormal areas in the breast that look like a cancer but turns out to be normal, this leads to false positive. Mammogram images are found to be difficult to interpret so a CAD is becoming an increasingly important tool to assist radiologist in the mammographic lesion interpretation. Preprocessing was considered as an important step in mammogram image analysis. Accuracy of preprocessing will determine the success of the remaining process such as segmentation, classification etc. In this paper, mean, median, adaptive median, Gaussian and wiener denoising filters are used to remove salt and pepper, speckle and gaussian noises from a mammogram image and these filters were compared based on the parameters such as PSNR,MSE and SNR to determine which filter is better for removing these noises in mammogram images.

Key words - CAD, PSNR, MSE, SNR, Mammogram, Mean filter, Median filter, wiener filter, Gaussian filter, Adaptive median filter, Preprocessing

I. INTRODUCTION

According to a new study, Breast malignancy has supplanted cervical growth as the main source of tumor passings among ladies in India, while passings because of lung disease beat the rundown for men. In 2013, 40,985 ladies died because of cervical malignancy while 47,587 passed on because of bosom growth. Breast malignancy is the commonest tumor of urban Indian ladies and the second commonest among the provincial ladies. Attributable to the absence of attention to this infection and without a breast malignancy screening program, the larger part of breast tumors are analyzed at a generally propelled arrange. The lifetime likelihood of creating breast malignancy in India is one in 22 ladies contrasted with one in eight in US and other developed nations. To examine human breast, a low energy x ray procedure is called mammography. Early detection and diagnosis is the ultimate goal of this procedure. Mammography is profoundly precise, yet like most therapeutic tests, it is not great. By and large, mammography will identify around 80–90% of the bosom growths in ladies without indications [1].Basically there are two types of mammogram they are 1. Screening mammogram 2.diagnostic mammogram. A screening mammogram is for women who have no problem with their breast while diagnostic mammogram is for evaluation of new abnormality. A screening mammogram is not usually recommended for age below 40,because the breast is found to be radiographically dense for such people.

Mammography can reduce the breast cancer mortality through a well organized screening program. It is currently the best technique for early detection, non-palpable, potentially curable breast cancer . This process is easy and has only few side effects Since the mammogram images are difficult to interpret than other medical images a CAD system was introduced. Which is considered as a second reader of mammographic images. Stages of a CAD system is shown below [2].

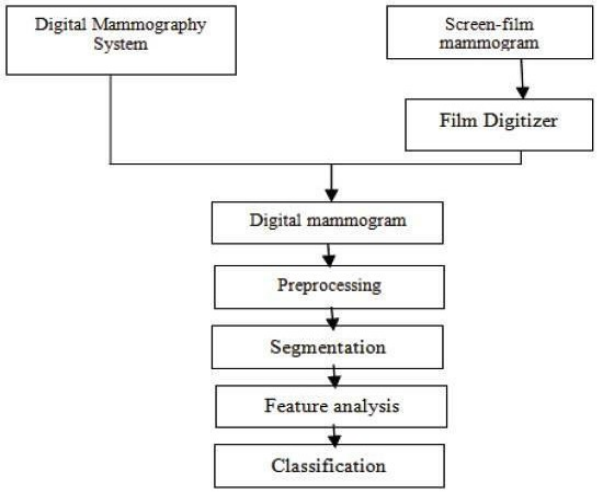

Fig 1: Stages of a CAD system

Preprocessing is considered as an important step in image processing. The accuracy of this step determine the probability of success of the remaining steps such as segmentation, classification etc. Unknown noise, poor image contrast, inhomogeneity, weak boundaries and unrelated parts are usual traits of clinical images. It will influence the substance of the medicinal pictures. This issues can be redressed by pre-preprocessing procedures. Preprocessing involve image

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resampling, grayscale contrast, enhancement, noise removal, mathematical operation and manual correction.

Prior to segmentation , an image enhancement techniques such as contrast enhancement technique applied to mammogram images then a linear contrast adjusting function (gamma correction value = 1)is applied to increase the image intensity contrast, and a mean filtering with a size of 30 x 30 pixels is applied to expel noises present in the image[8] .For reducing the interference and improve the detection accuracy, a maximum connected region marking and region growing method used to remove label and pectoral muscle[1].Morphological operations used for the digitized noise and artifacts removal [9] and a seeded region growing method used to remove Pectoral muscle.

A shrink wrap function is used for improving the quality of mammography and this function amplifies areas of high intensity and segments them using a front[10]. The front is introduced on the raised body (for speed) and dissolves the guide until it has focalized on the edge of the ranges to continue, keeping up edge geometry

Noise removing based on morphological techniques called "opening-by-reconstruction" and "closing-by-reconstruction"[10]. Erosion followed by a morphological reconstruction is the opening by reconstruction and by dilation followed by a morphological reconstruction "closing-by-reconstruction"[11].

In order to remove noise,a local area histogram equalization is used and then a median filtering is used[9]. The power of image pixel is extended to develop the difference in histogram evening out stage and the middle channel to evacuate commotion.

Image enhancement is classified into two categories-global and local techniques. The global technique involve histogram equalization, contrast stretching and convolutional masking enhancement. The local technique involve fixed and adaptive neighbourhood enhancement and region based method enhancement.

II. PREPROCESSING

Preprocessing is considered as the basic step in any image processing technique. The ultimate goal of this technique is to improve the quality of the image that suppress unwanted distortions or enhance some image features which is important for further processing. Compared with other medical images mammogram images are difficult to interpret hence preprocessing is essential[3]. An image preprocessing significantly increase the reliability of an optical inspection and uses the considerable redundancy in images. This paper intend to review various filtering techniques in mammograms for noise removal.

Filtering

In image handling the role of filter is to stifle either the high recurrence or low recurrence in a picture. That is either to smoothing the picture or upgrading and distinguishing edges in the picture. Sifting can be performed either in recurrence space or in spatial area. There are diverse sorts of separating procedures exist

Median filtering

Median filtering is a nonlinear operation frequently utilized as a part of picture handling to decrease salt and pepper and spot noise[7]. This sort of separating keep the sharpness of a picture edge while evacuating clamors. In this filter the neighboring pixels are ranked according to brightness and middle esteem

turn into the new incentive for the focal pixel. While sifting this filter does not move limits as can occur with traditional smoothing filters. Since the middle is less touchy than the intend to outrageous qualities that can be more viably evacuated. Median filter can be connected over and again if essential since the edges are negligibly debased. Digitization commotions, for example, straight lines exhibit in the dominant part of procured mammogram images can be sifted utilizing a two-dimensional (2D) median Filtering approach in a 3-by-3 neighborhood association [5][4].The fundamental inconveniences of median filters are ,it will make another flag point that does not exist in unique flag and which might be undesirable in some application. The median filter may removes both the noise and the fine detail. Anything relatively small in size compared to the size of the neighborhood will have only minimal affect on the value of the median, and will be filtered out that is, the median filter can't distinguish fine detail from noise.

mean filtering

Mean filter is also known as average filter. The goal is just to enhance the image quality for human perspective. In mean filtering each pixel is supplanted with mean value of intensity in the neighbourhood[3].That is at each position the centre pixel is replaced with average value. These filters are simple, intuitive and easy to implement that is reducing the amount of intensity variation between one pixel and the following. Average filtering is usually thought of as a convolutional filter. This filter work as lowpass one . Mean filter can be used for the images that is corrupted by impulse noise just to attenuate and diffused not to remove it. Filtering operations are easier to carry out but the averaging operation may leads to blurring of an image. In mammogram images the nearness of clamor may bring about uncertain component extraction., hence, the Mass Detection utilizes the mean filter to dispense with short-followed commotion, for example, uniform and Gaussian-sort noise[6].

Adaptive Median filter

These filter will protect the edges of the picture and without obscuring it is utilized to smooth the non loathsome commotion from 2D signal. It take a shot at a rectangular region[3]. Adaptive filtering can likewise lessen bends like inordinate diminishing or thickening of protest limits. This sifting performs spatial handling

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to figure out which pixel in a picture have been influenced by impulse noise. The threshold for the comparison as well as size of the neighbourhood is adjustable in adaptive median filtering. It groups the pixels as clamors by contrasting every pixel and the neighboring pixel in an image. For an adaptive filter Whenever the MSE value minimum, the PSNR value provides maximum results.[15]

Wiener filtering

Wiener filtering is an optimal filter in terms of MSE, that is, it reduces the overall MSE in the process of noise smoothing and inverse filtering. This filter gives a linear estimation of original image. The goal is to compute a statistical estimate of unknown signal using a associated signal as an input and filtering that regarded signal to supply the estimate as an output. Wiener filter will remove additive noise and inverts the blurring simultaneously. Wiener filtering is superior. It gives the ideal method for decreasing the boisterous parts, in order to give the best remaking of the first signal[12]. Wiener filtering is a general method for discovering best remaking of a noisy signal which will provide a straight estimation of the first picture. Based on the psycho-visual criterion, the expert radiologist confirmed that this filter does not affect the structure of the mammographic image, but provides improved visibility[13]. Assuming known stationary signal and clamor spectra, and added substance commotion the Wiener filter is a filter used to create a gauge of a fancied or target arbitrary process by linear time-invariant (LTI) sifting of a watched loud process. This clamor filter depends on Fourier cycle. Its primary preference is the short computational time it takes to discover a solution

Gaussian filter

Gaussian filters is considered as an ideal time domain filter. It is one of the non uniform lowpass filter. The impulse response of such filters is a Gaussian function that is gaussian filters are those filters with Gaussian function. It have a minimum possible group delay. The main function of Gaussian filter is to minimize the low and high signals from distortion [14]. In an image handling, a gaussian obscure which is otherwise called gaussian smoothening is an aftereffect of obscuring of a picture by a gaussian capacity. This gaussian smoothening administrator is typically a 2-D convolutional administrator to obscure pictures and expel subtle elements and clamors. S alt and pepper is usually more challenging for gaussian filter. One of the major drawback of Gaussian filter is it take much time comparing with the other filters. Gaussian filterss as a rule having no overshoot to a stage work input while limiting the ascent time and fall time.

III. RESULT AND DISCUSSION

To estimate the performance analysis of mean, median, adaptive, wiener and gausssian filter in mammogram images we determined the quality parameters such as PSNR,SNR and MSE for a given image. The test was conducted against speckle noise, salt and pepper noise and gaussian noise. Each of these noisy images where given as the input to all five different filters. The examinations where directed with mammographic picture undermined by gaussian commotion with mean 0 and change 0.01,speckle clamor with difference 0.04 and salt and pepper commotion with noise density 0.05.For mean filter when the test was conducted against these noisy images the following filtered outputs where obtained.

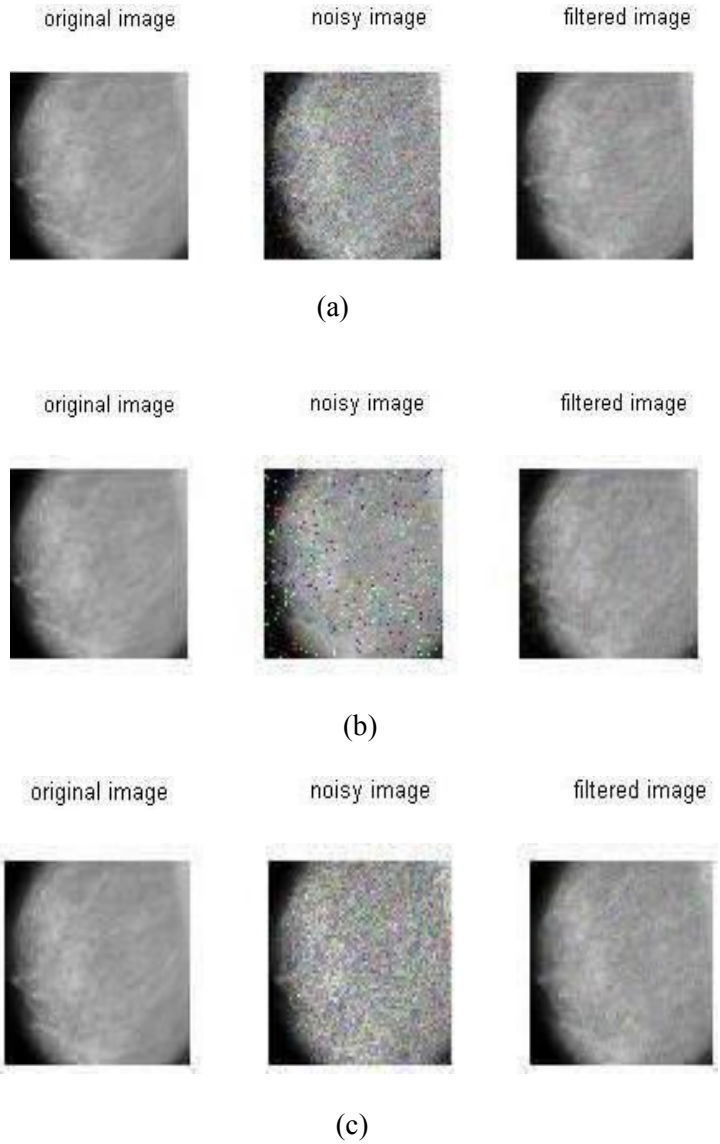

Fig 2. (a) Mean filtered gaussian noise (b) Mean filtered salt and pepper noise (c) Mean filtered speckle noise

Fig 2 shows that mean filter works quite well for gaussian noise but rapidly diminishes the quality of image due to the blurring effect it introduces. This mean filter act as lowpass frequency filter and therefore reduces the spatial intensity derivatives in the image.

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For median filter when the test was conducted against these noisy images the following results where obtained. Which shows that median filter is good in expelling salt and pepper noise, that is, noise is completely eliminated with almost no degradation to the underlying image and found to be less effective in removing noise from image corrupted with gaussian noise. These filters preserved the sharp edges while removing the noises.

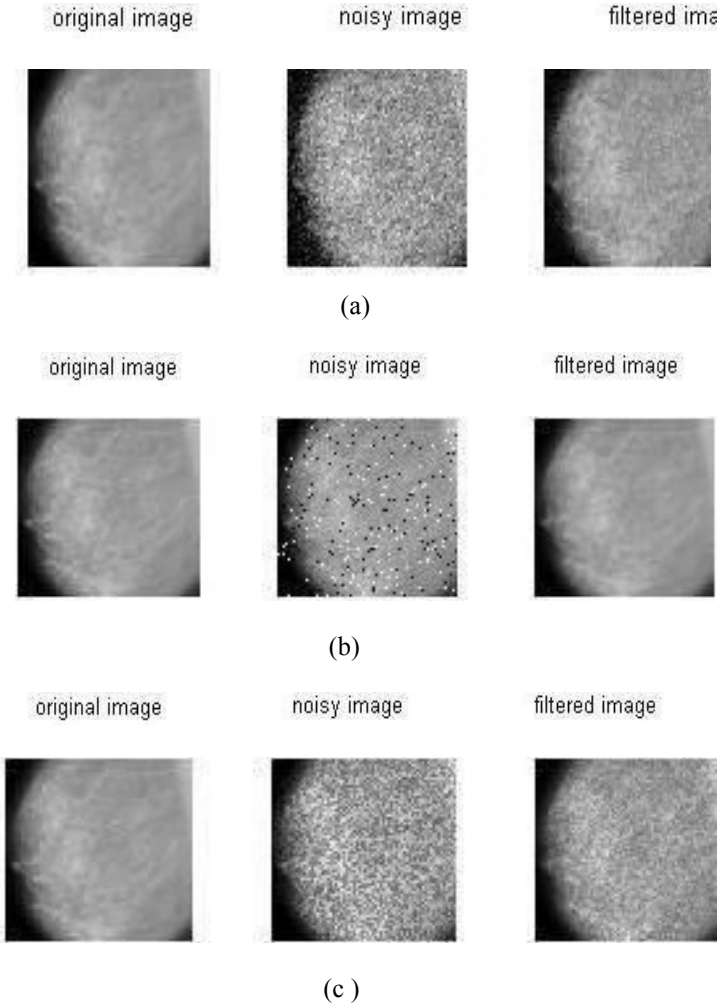


Fig 3. (a) Median filtered gaussian noise (b) Median filtered salt and pepper noise (c) Median filtered speckle noise

An adaptive median perform separating without obscuring edges and preserve images .This makes it especially appropriate for mammogram image enhancement. For this filter when the test was directed against gaussian commotion, salt and pepper clamor and speckle noise undermined mammogram images the accompanying outcomes where obtained.

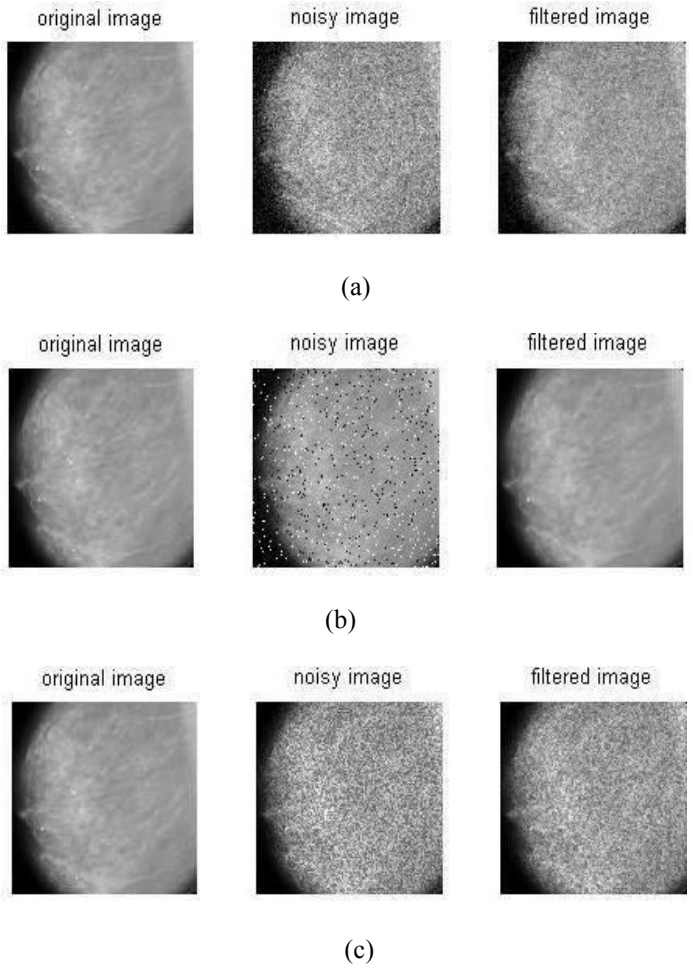
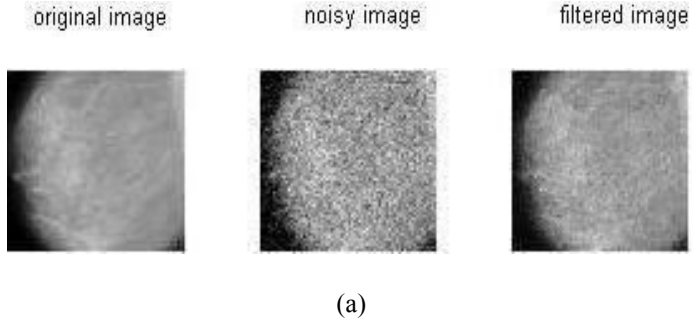


Fig 4. (a) Adaptive median filtered gaussian noise (b) Adaptive median filtered salt and pepper noise (c)Adaptive median filtered speckle noise

Figure 4 shows that adaptive filter works better for salt and pepper noise compared with speckle noise and gaussian noise. For wiener filter when the test was conducted against these noisy images the following results where obtained.



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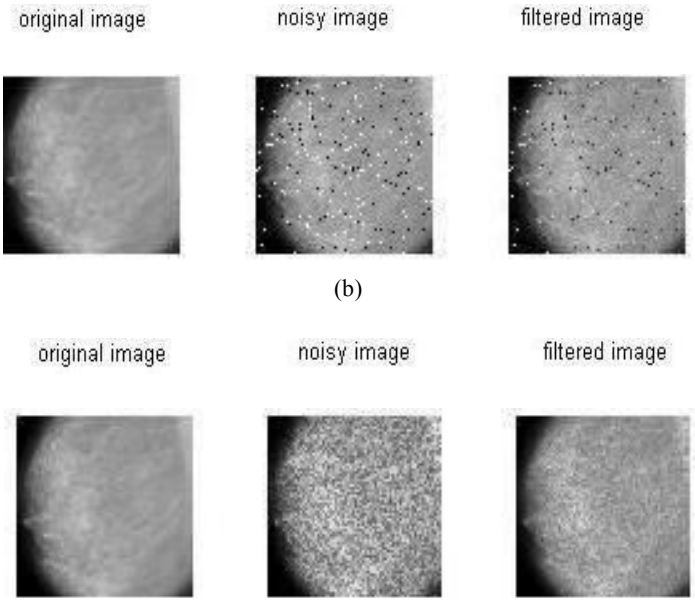
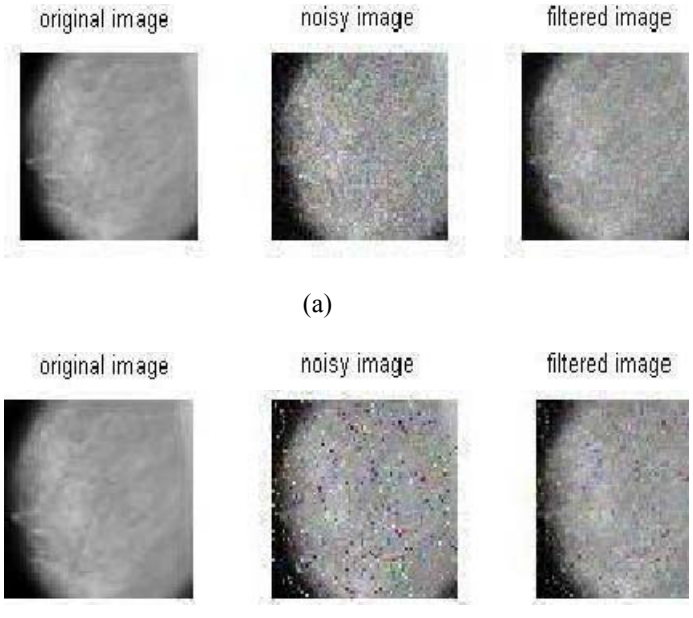


Fig 5. (a) Wiener filtered gaussian noise (b) Wiener filtered salt and pepper noise (c) Wiener filtered speckle noise

From fig 5 it is clear that wiener filter can remove gaussian noise as well as speckle noise up to a limit, but salt and pepper and can not remove completely. For gaussian filter when the test was conducted against these noisy images the following results where obtained.



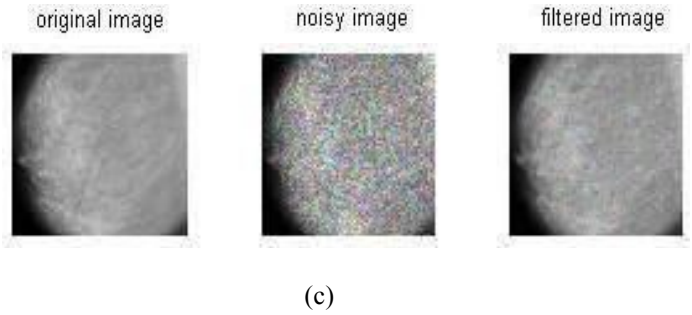


Fig 6. (a) Gaussian filtered gaussian noise (b) Gaussian filtered salt and pepper noise (c) Gaussian filtered speckle noise

From figure 6 it is clear that salt and pepper noise is more challenging for gaussian filter. It can better remove speckle noise.

Performance of filters based on MSE

Mean square error is considered as one of the parameter which determine an image quality. higher value of MSE refers lower image quality. In this paper we estimated the MSE for the filters such as mean, median ,gaussian, wiener, and adaptive median filter against salt and pepper noise, speckle noise and gaussian noise. The figure below shows the obtained result.

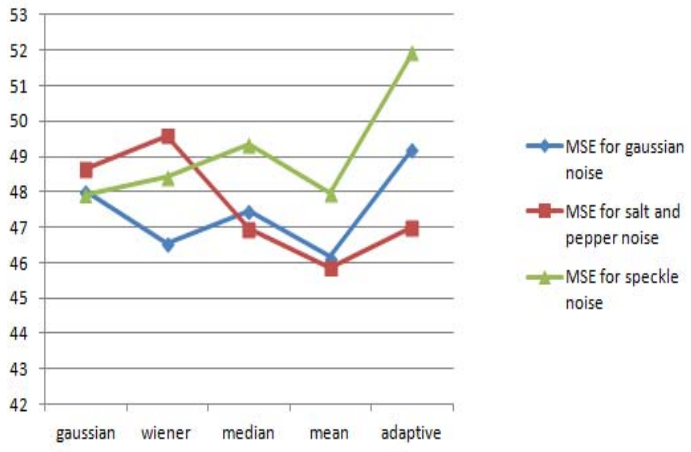


Fig 7.Performance of filters based on MSE

Performance of filters based on PSNR

Larger value of PSNR stick out a smaller contrast amongst orginal and reproduced picture. This quality parameter does not reflect perceptual quality. Smaller value of PSNR indicate poor image quality. Figure 8 shows the obtained result for PSNR for different filters at gaussian noise, salt and pepper noise and speckle noise.

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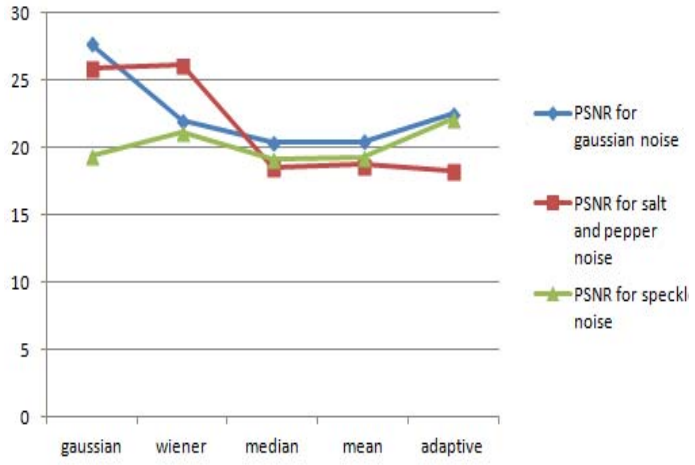

Fig 8.Performance of filters based on PSNR

Performance of filters based on SNR

This quality parameter is a physical measure of sensitivity of a imaging system. SNR is defined as the propotion of power of a signal to the power of background noise. The figure below shows the experiment result of mammogram images for calculating the SNR for different filters against specified three noises

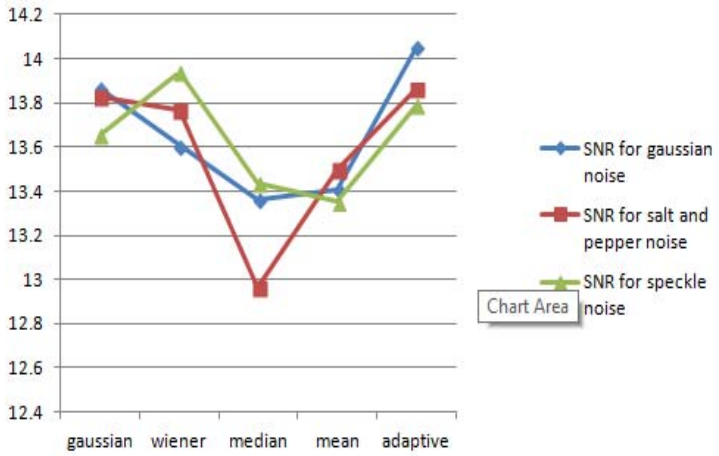

Fig 9.Performance of filters based on SNR

CONCLUSION

Preprocessing is the most vital and essential stride in the mammogram analysis because of poor mammogram picture quality. It is important to redress the mammogram images for further processing and analysis. Distinctive sorts of sifting systems are accessible for pre-processing mammogram images. Filters are utilized to enhance picture quality, evacuate the clamor, saves the edges inside a picture, improve and smoothen the image and so on. Speckle clamor, salt and pepper commotion and gaussian clamor are the basic noises found in mammogram images.. In this paper we looked at the performance of mean, median, wiener, adaptive median and gaussian filter based on the quality parameters such as MSE, SNR and PSNR with speckle noise, salt and pepper noise and gaussian noise defiled images. Median filter is found to be better in preserving sharp edges and is less sensitive to outliers than mean filters. From the analysis of filters it is found that gaussian noise can be better removed by mean filter and wiener filter can also remove this noise up to an extend compared with median, adaptive and gaussian filter. Mammogram image corrupted with speckle noise can be better reconstructed with gaussian filter, wiener filter and mean filter. Mean filter, median filter and adaptive median filter works better for salt and pepper noise

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