Improved Methods for Mammogram Breast Cancer Using by Denoising Filtering

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Abstract

In diagnosing breast cancer, digital mammograms have shown their effectiveness as an appropriate and simple instrument in the early detection of tumor. Mammograms offer helpful cancer symptoms information, including microcalcifications and masses, which are not easy to distinguish because there are some flaws with the mammography images, including low contrast, high noise, fuzzy and blur. Additionally, there is a major problem with mammography because of a high density of the breast which conceals As a result of the mammographic image, it is more difficult to distinguish between the tissues with normal dense and the tissues that are cancerous. Therefore, mammography images need to be improved in order to accurately identify and diagnose breast cancer. The most typical goals of images enhancement are to remove noise and improve image details. With the aid of mammography image processing techniques, a special data including distinctive characteristics of tumors can be differentiated, this could help distinguish between malignant and benign cancers. This work focuses on removing noise of pepper & salt, improving image to increase the quality of mammography and enhance early detection of breast cancer. A specific approach is employed to do this, including of two phases of image denoising base filtration and one phase to improve contrast. The stages of filtering contain the using of wiener and median filters. The contrast enhancement stage utilizes (CLAHE) which is an abbreviation for contrast limited adaptive histogram equalization. Evaluating the performance is done via contrast histogram for the CLAHE and MSE & PSNF for the filters. The results
demonstrate that the work technique is doing better when put to comparison with other approaches in term of low MSE (1.1645) and high PSNR (47.4750). The technique will be assessed with additional kinds of noise for future work.

Keywords
Mammogram, Contrast Enhancement, Removing Noises, (CLAHE).

Introduction

When talking about cancer types that affect women, one of the most dangerous of them is breast cancer. Breast cancer affects more than “11%” women throughout their life (Veldkamp, et al., 2000). The (IARC) which is an abbreviation of International Agency for Research on Cancer, also it is part of The World Health Organization, estimated that over 1 million breast cancer cases are going to take place every year, also over 400 thousand women pass away annually because of breast cancer. Detecting this disease in its early stages is important in decreasing fatalities (Urban, et al., 2012).

Yet, it is not easy to achieve early breast cancer detection. In spite of the fact that the most exact detection technique in medical field is biopsy, it is considered as an aggressive invasive method which include few risks, such as the high cost and inconvenience to the patient (Eltoukhy, et al., 2009).

A lot of methods are used for the detection of breast lesions, such as magnetic resonance imaging and ultrasonography. Nevertheless, mammography proved that it is the most precise tool for the purpose of breast cancer’s detection in the first and most curable stage of it, thus, it carries on with being the most essential imaging modality for screening and diagnosing breast cancer (Dos, et al., 2012) (Urban, et al., 2012). (American cancer society).

Obscuring the mammographic image is considered as one of the main problems related to Mammography because of the high density of the breast. The breasts of women are denser by nature, or extra glandular in youth, this is the reason of the difficulty the radiologists face when they try to examine the mammogram image. There is a rapid change in the technologies regarding breast cancer detection, with the latest utilized techniques in the field such as computer aided detection and digital mammography. Image’s enhancement through a manipulation process of nuances in intensity using image processing algorithms will create a base for new detection system aided by computer (Eltoukhy, et al., 2009).
**Problem Background**

Quantum noise dominate in circumstances in which the image is produced through the process of photos’ accumulation over a detector. Some examples are existed in infrared photometers, mammograms, CCD cameras, and standard x-ray films (Mundher, et al., 2013) (Naseem, et al., 2012).

The most used method by radiologists to diagnose and screen breast cancer is the X-ray mammography (Mencattini, et al., 2008). However, as a result of the restrictions hardware system of X-ray in machines of mammogram, the quality regarding images of breast mammogram could experience low contrast or resolution (Naseem, et al., 2012). In spite of the fact that it is considered as the most dependable approach for quick detection of breast carcinomas, decreasing the rates of mortality by up to “25%”, its interpretation is very difficult where “10%–30%” of breast lesions are missed during routine screening (Mencattini, et al., 2008).

A lot of problems occur to X-ray mammography. Quantum noise is considered as the main problem that is more likely to appear in images of mammogram because of electrical fluctuation (Naveed, et al., 2011). The mammogram images suffer Quantum noise through acquisition because of the low count photons of X-ray. It does affect the image’s quality and the accuracy of classification for classifying images to malignant and benign (Eltoukhy, et al., 2009).

Additionally, there is a main problem with Mammography because of the density of the breast which conceal the mammographic image causing increase in differentiating the difficulty between cancerous and normal dense tissue when trying to find small tumors surrounded by glandular tissue. For the purpose of increasing the efficiency of diagnostic made by radiologists, a number of computer-assisted diagnosis methods were introduced to enhance detection of one of two main signatures regarding the disease named micro-calcifications and masses.

Improving Mass bring more complicated problems when compared to micro-calcifications. Actually, considering the low contrast, both seem to be camouflaged and embedded through varying densities regarding parenchymal tissues structure. Therefore, the process of visually detecting them on mammogram is difficult (Mencattini, et al., 2008).
Radiologists generally evaluate the breast density via visually judging the image of the breast. Therefore, automatic tissue classification techniques attempt to emulate this visual judgment, taking advantage of the radiologist’s knowledge. Regarding literature, various methods were proposed for breast tissue classification based on utilizing only histogram information (Zhou, et al., 2001). Density of radiographic is a measure or scheme aiming to find or determine a connection between cancer risk and density, however, the approach was short on objectivity because of the inter and intra variations of the observer.

Not long ago, researchers utilized a lot of methods for analyzing the image’s radiographic density and applied many methods to classify density pattern of breast. When the computer starts analyzing mammograms, the pectoral muscle must be excluded from processing purposed for tissue of the breast. In literature various methods regarding automatic segmentation for the pectoral muscle were suggested. Segmentation process of pectoral and breast muscles are usually requirement for automatic evaluation of density breast (Kwok, et al., 2004).

However, in most methods used, the whole breast together with the pectoral muscle were suggested for feature extraction. The process of including the pectoral muscle may influence the outcome of image processing based on intensity approaches in detecting the densities of the breast (Veldkamp, et al., 2000).

The proposal Technique Design

The research aims to enhance the mammogram image contrast and suppress the noise. For contrast enhancement, a generalization of adaptive histogram equalization called (CLAHE) is utilized, which is an abbreviation of contrast limited adaptive histogram equalization. For removing noise, two stages image denoising base of filtering are used. These two filtering stages are used to suppress image’s noise. Therefore, the noise in the first stage is removed. The remaining noise in form of random dark or light spots is tackled during contrast enhancement. In the second stage of filtering, any remaining noise from first stage in addition to the possible noise that may produce by the contrast enhancement is treated. The proposed design of the research technique is illustrated in figure 1 below.
Median Filter (MF)

It is a nonlinear spatial filter. Median filter could be utilized for the purpose of removing image’s ‘speckle’ noise, also it MF perform better than linear low pass filters, regarding the discussed noise type (Al-amr, et al., 2010). MF is utilized widely in urging noise removal techniques because of its computational adequacy and denoising ability (Hosseini, et al., 2011). In general, MF is utilized to smooth images and reduce noise without cause blur in the edges (Ilango, et al., 2011). One of the most used non-linear filters for removing Salt & Pepper noise is the MF (Maheswari, et al., 2010) (Ramani, et al., 2013). Some types of MF are I) weighted MF II) Centre-weighted MF III) Max-MF, the window size effect increase in removing of MF noise effectively (Ramani, et al., 2013).
MF is depend on a moving of window over the image and calculates the output pixel as the median brightness value in the input window. If window size is \((J \times K)\), we can order pixels \((J \times K)\) from the smallest to the biggest in brightness value. If \((J \times K)\) is strange then the median will be in the ordered brightness list \((J \times K + 1/2)\) (Khireddine, et al., 2007).

One of the main disadvantages of the basic MF is that it looks for altering pixels that are not affected by noise (Ilango, et al., 2011). However, it often fails to perform well in denoising additive Gaussian noise.

This filter is used firstly because it can reduce noise and smooth the images without blurring edges. In addition, it can perform well with different noises. If this filter modifies the pixels that did not disturbed by noise, we can handle it in the other stages.

**Contrast Limited Adaptive Histogram Equalization (CLAHE)**

It is considered as a significant technique of histogram equalization approach that work in adaptive way on images that require improvement. The Pixels intensity undergo a process of transforming to a value in display range which is proportional to the rank of intensity pixel in histogram of local intensity. CLAHE is considered as an upgrade of the (AHE) Adaptive Histogram Equalization where that calculating the enhancements is being adjusted through imposing a maximum defined by the user, i.e. clip level, to the height of local histogram, consequently on maximum contrast enhancement factor. The improvement is applied in highly uniformy image areas, that block high noise enhancement and lessen edge-shadowing impact of unlimited AHE (Maitra, et al., 2012).

Histogram equalization (HE) as an image processing method that is utilized for adjusting the contrast by utilizing the histogram of the image. HE produces noise and doesn’t maintain the input image’s average brightness; therefore, the output image that were processed will frequently appear bright in unnatural way. Equalization of Histogram could decrease the usable noise and the background noise’s contrast. To enhance the HE performance and improve images contrast, CLAHE is utilized. This approach can handle the problem of noise amplification of histogram equalization.

The CLAHE operate on the “tiles”, tiles are small image regions, instead of operating on the whole image, an enhancement process is done for each tile’s contrast, after than all the adjacent tiles combined by utilizing bilinear interpolation for the purpose of eliminating boundaries that were artificially induced. The contrast could be limited specifically in homogenous areas in order to keep away from amplifying noise and reducing edge-
shadowing impact which could be existed in image (Maitra, et al., 2012). AHE is able to improve the image's local contrast, providing extra details in image. But, it may also result some noise (Vij, et al., 2009).

To overcome this problem, two stages image denoising base filtering is used. In the first stage, the median filter is used, and in the second stage, the wiener filter is used. The “CLAHE” can improve the image’s local contrast and provide extra detail in the image, but it will increase the noise same as most control enhancement techniques. The noise increase will not reach unsatisfied level because the noise is already suppressed by the median filter in the first filtering stage.

**Wiener Filter**

This filter is an optimum filter tries to get the optimum estimation regarding the original image using a minimum MSE constraint between the original and estimate image (Naseem, et al., 2012).

Wiener filter is utilized for the purpose of reducing the noise in the signal via comparison process with an estimation regarding the required noiseless signal. Wiener filter is the classical denoising filter, which is a linear filter that reduces the MSE. This filter is better than a similar linear filter because it can handle edges and other image high frequency parts (Mayo, et al., 2004).

The error between the estimated signal \( f(m, n) \) and the input signal \( f(m, n) \) is specified by (Ramani et al., 2013).

\[
E(m,n)=f(m,n)-f(m,n)
\]  
\[1\]

“The square error” is given by  
\[
[f(m,n)-f(m,n)]^2
\]  
\[2\]

“The mean square error” is given by  
\[
E[\{f(m,n)-f(m,n)\}^2]
\]  
\[3\]

Wiener filter is considered as one of the best linear filtering techniques, also it is known for its good performance in the process of denoising white noise (Kumar, et al., 2011). Wiener filter can handle the possible quantum noise in images (Naveed, et al., 2011).

This filter is used in the second stage of filtering because it has the ability to minimize the mean squared error (MSE), which is an effective performance measure. It is expected that the output image will have better contrast variance and low noise.
Results and Discussion

There are many advantages when utilizing Digital mammography in comparison with conventional film mammography like the easy process of transmitting to other physicians, simple image storage, short exams, and faster image acquisition. Furthermore, processing breast images with computer have more accuracy in detecting breast cancer (Maitra, et al., 2012).

The literature demonstrated the effectiveness of the digital mammography in diagnosing breast cancer as an easy and adequate tool in detection tumors in their early stages. Using mammography image processing techniques can differentiate a particular data including certain tumor characteristics that might help with the classification of benign and malignant tumors (Eltoukhy, et al., 2009). The main approach of this research is to enhance the mammogram images by removing noise and enhancing the images contrast.

Figure 2 The noise are removed
Images Qualities

The original images to the first stage are corrupted by Salt and Pepper noise with various standard deviations. The Output image when the salt and pepper is shown in figure 2.

The results of each stage regarding MSE and PSNR are separated in tables 1, and 2, for the purpose of facilitating the process of comparison between stages. The results are based on the images that subjected to noise densities. The PSNR and MSE of the images corrupted with various noise densities.

It can be concluded from all images that the proposed technique is succeeded in enhancing the image quality. The median filter in the first stage removes most of the salt and pepper noise. The CLAHE in the second stage enhances the overall image contrast dramatically. The wiener filter impact is not clearly shown on the images but some of the distorted edges in the output images of the CLAHE are enhanced slightly as shown in figure 3.

![Figure 3 Enhancement Result](image)

(a) CLAHE output, (b) Wiener output

<table>
<thead>
<tr>
<th>Filter Name</th>
<th>Noise</th>
<th>Image</th>
<th>MSE</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Filter</td>
<td>Salt &amp; pepper</td>
<td>Mdb0.019</td>
<td>1.2781e+03</td>
<td>39.2937</td>
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<td>1.3262e+03</td>
<td>38.9248</td>
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<th>Image</th>
<th>MSE</th>
<th>PSNR</th>
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<td>1.1630</td>
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</tbody>
</table>
Contrast Histogram

CLAHE is utilized to mammogram images. The main idea of the technique is adjusting the input image’s histogram to uniform one. Narrow contrast histogram indicates an image with low-contrast (Morrow, et al., 1992). It can be seen from the contrast histogram graph in figure 5 before using the CLAHE, that the image contrast is not uniform. After applying the CLAHE, the input image histogram is distributed uniformly.

Figure 4 (a) and (b) shows a narrow contrast histogram of the noisy and original image Mdb0.019, (c) is the output of the first stage of the research technique represented by the median filter, (d) shows the positive effect of the second stage of the research technique represented by the CLAHE, (e) shows the final image of the last stage of proposed technique represented by the wiener filter

Conclusion

The aim of this technique is to improve the contrast of the images of mammogram without boosting noise and to simplify the diagnosing of breast cancer. As a result, noise reduction and contrast improvement have been carried out. The method that were described were put to test on a lot of mammographic images taken from the digital mammography database of Mammography Image Analysis Society (MIAS). All images corrupted through the Pepper and Salt noise with various densities. Noise removal is performed through two stages by utilizing median and wiener filters, while contrast enhancement is performed through one stage it is by CLAHE. This noise is quantified by using PSNR and MSE and contrast is evaluated by histogram.
Through the application of the proposed technique, it has been ability to enhance all the mammogram images quality. Below some of features were concluded by using this method:

- The median filter succeeded in removing most of the pepper and salt noise from the mammogram images.
- The CLAHE has distributed the image contrast normally but it caused some blurring in some edges.
- The wiener filter has succeeded to some extent in removing some of the distortions of edges of the CLAHE output images.
- In terms of low MSE and high PSNR, the research method performs better than the performance of each stage.
- The performance in this paper is better than the performance of the median and wiener filters separately in terms of high PSNR and low MSE.
- The MF is better than the wiener in removing Pepper and Salt noise as indicated by previous researches in the literature.

In terms of PSNR, the research method is better than mean and adaptive MFs.

References


