The Application of Image Filtering Methods in Mammography Image

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Abstract: Medical images have recently become an important part of patient care. Techniques for image processing and analysis are generally used in medicine. Medical images are complicated, and they differ significantly from one application to the next. Image processing is required to obtain high-quality medical images for accurate diagnosis. In medical applications, the purpose of image processing and analysis is to improve image quality and extract quantitative information from images as efficiently and accurately as possible. In this paper, noise reduction filters were used to improve the mammography image. Filters are used to improve noise and reduce noises by the linear filter, median filter, and wiener filter. Filtering processes have been applied to image formats with medical content, such as mammography images, which are different from standard digital images. In addition, metrics such as peak signal to noise ratio (PSNR), which enables the performance of different filtering techniques to be evaluated, were also calculated and compared.

Keywords: Mammogram, medical image processing, filtering, image quality metric

1. INTRODUCTION

Today, digital images have important uses for many applications. It is very common to use images produced by many methods such as mammography, magnetic resonance imaging, computed tomography, and ultrasound, especially in the diagnosis and treatment of diseases in the medical field [1,2]. Image processing methods can basically be used to enhance images and reveal information in images. Image filtering techniques are used to obtain such information from the image. They are the commonly used image processing methods in which many operations such as image filtering, image enhancement, noise removal on the image, edge detection, texture recognition are performed with linear convolution or correlation [2-4].

Images in medical applications can be acquired more complexly than other images. Image processing is necessary to have high quality medical images and reliable diagnoses. The purpose of image processing applied to medical treatments is to enhance the quality of images and to accurately extract quantitative information from image data [5]. Image quality is important for the reliable acquisition of medical images of the organ prescribed for correct diagnosis or treatment [3]. The most important physical property used to describe image quality is noise [5].

Image filtering is one of the most critical processing that has a significant impact on the quality of medical images. Image filtering is processing that removes noise and enhances

image resolution. Any unnecessary information that impairs accurate imaging of an object is referred to as noise. The most common cause of image quality degradation is noise. Because of these situations, filters are widely used to remove the noise in the mammography image. The mammography image used in the study belongs to the Mammographic Image Analysis Society (MIAS) data set [6,7]. Filtering as linear filter, median filter, and wiener filter have been carried out on the mammographic image in the MIAS data set. Peak Signal-to-ratio (PSNR) calculation was used to numerically evaluate the success of such filter methods.

2. MATERIAL AND METHODS

Noise characteristics in medical images depend on many factors. High frequency data in noises can be easily filtered. Noises that distort the image can take names such as gaussian, speckle, salt and pepper [5]. Linear filters, median filters and wiener filters are used to reduce noise in medical images. Linear filters are used to reduce certain types of noise if an example is given Gaussian filters are of the linear filter. In median filters, in addition to the operations in linear filtering, the value of the resulting pixel is determined by the average value of neighboring pixels. Wiener filters are used to optimize the local image variance. They are more selective than linear filters in finding edges or other regions in the image [8].

First, gaussian noise was applied to the mammography image to determine the performance of the filters [9]. Gaussian noise added white noise to the image according to the mean and variance values. The noise added zero-mean for white noise (Gaussian noise) with a variance of 0.01 to image, while the original mage has been degraded in a controlled manner. Then, linear filter, median filter, and wiener filter were used and also comparison of these filters was made according to PSNR. The techniques used were carried out using the default values in the MATLAB2021b program in this study [9].

$$MSE = \frac{1}{MN}\sum_{X=0}^{M-1}\sum_{y=0}^{N-1}\|g(x,y) - h(x,y)\|^2 \quad (1)$$

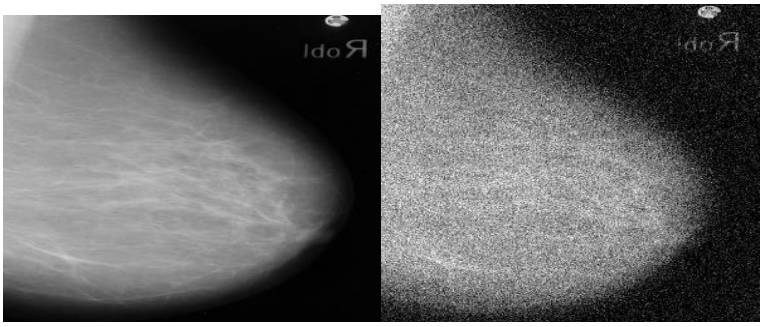
Mean square error (MSE), $g(x,y)$ is the matrix of the input image, $h(x,y)$ is the matrix of the filtered image. M is the image's row number of pixels. x is the row, N represents the column number of pixels in the image, and represents the y column in Eq. (1). The mathematical expression of PSNR is shown in Eq. (2). MSE stands for the square of the mean errors. In Eq. (2), Max_f represents the maximum value that pixels in the input image [10]. PSNR is defined as the ratio of desirable signal information or power to undesired background noise signal or power. Image quality is indicated by a greater PSNR score. A low

PSNR value, on the other hand, indicates low image quality by expressing the high numerical difference between images.

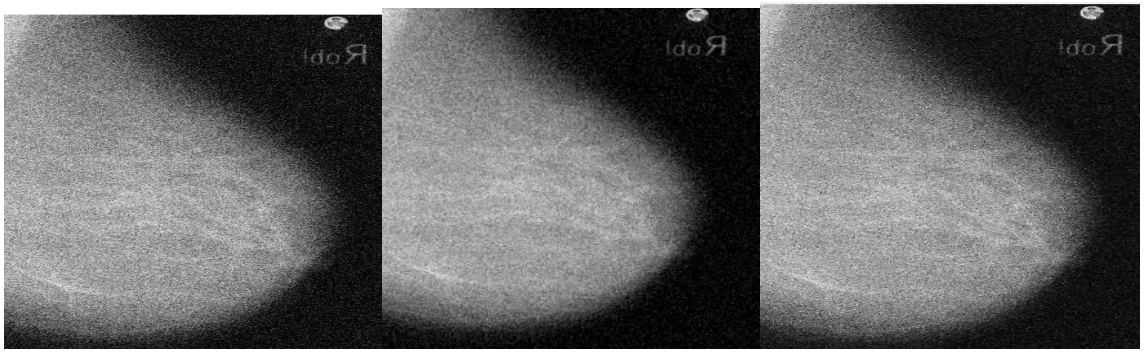
$$PSNR = 20log_{10}\left(\frac{Max_f}{\sqrt{MSE}}\right) \quad (2)$$

3. RESULTS

Mammographic image is available via mini-MIAS data set. The results of filtering operations performed with mini-MIAS mammography (mdb070) data are shown in Figure 1. The mdb070 image has been provided with appropriate details as the background tissue is fatty. Also, the class of abnormality present is normal in the mini-MIAS database. Figure 1(a) shows the original mammography image (mdb070), whereas Figure 1(b) shows the same image with gaussian noise. Figure 1(c) shows the image after the Gaussian filter, which is one of the linear filters, the image after the median filtering in Figure 1(d), and the image after the wiener filtering in Figure 1(e).



(a) Original image (b) Noisy image



(c) Gaussian filter (d) Median filter (e) Wiener filter

Figure 1. (a) Original image (b) Noisy image (c) Gaussian filter (d) Median filter (e) Wiener filter

PSNR is used to measure the objective image quality of the images in the research. The original and noise-distorted pictures are compared to the image PSNRs after filtering operations (Table 1). Figure 1 shows the images filtered using Gaussian filter, median filter, and wiener filter, respectively. In the PSNR results of these images, the wiener filter was higher (Table 1).

Table 1. PSNR scores after filtering of noisy image

	Noisy Image	Gaussian Filter	Mean Filter	Wiener Filter
PSNR(dB)	16.72	18.23	18.27	21.34

3. CONCLUSION

Image processing methods are applied to medical images for diagnosis provides quantitative information data important in the treatment and patient care, as well as qualitatively improving the acquired image. Advanced image processing techniques are widely used in medicine. Medical images are quantitatively analyzed and visualized using the MATLAB program. This study is aimed to remove the noise with various filters as linear filter, median filter, and wiener filter after adding noise to the mammography image via MATLAB2021b. As a result of the visual evaluation of the images after filtering and the comparison of the SNR values, the best result was obtained from the wiener filter. The success of the proposed filtering method for other noise types can be discussed in future studies.

REFERENCES

[1] Li, G., Miller, RW. Volumetric Image Registration of Multi-modality Images of CT, MRI and PET, Biomedical Imaging, Youxin Mao (Ed.), InTech, 2010.
[2] Bankman, I. Handbook of Medical Imaging, Academic Press, United States of America, 2000.
[3] O' Gorman, L., Sammon, M., Seul M. Practicals Algorithms for image analysis, (second edition), Cambridge University Press, United States of America, 2008.
[4] Toprak, A., Guler, I. (2006). Suppression of Impulse Noise in Medical Images with the Use of Fuzzy Adaptive Median Filter. *Journal of Medical Systems*, 30, 465-471.
[5] Gonzalez, R.C., Woods, R. E. Digital Image Processing. 3rd ed. USA: Prentice-Hall, Inc., 2014.
[6] "The mini-MIAS database of mammograms", PEIPA, the Pilot European Image Processing Archive, 02.11.2021, Avaliable http://peipa.essex.ac.uk/info/mias.html
[7] Suckling, J., Parker, J., Dance, D. (1994). The Mammographic Image Analysis Society Digital Mammogram Database, *Exerpta Medica, International Congress* Series, 1069, 375-378.
[8] Ortiz, F., Torres, F., Gil, P., "Gaussian Noise Elimination in Colour Images by Vector- Connected Filters", 17th International Conference on Pattern Recognition, pt. 4, Vol.4, p 807-10, 2004.
[9] MathWorks Inc. (2009) MATLAB User's Guide. The MathWorks Inc., United States of America.
[10] Wang, Z., Bovik, A. C., Sheikh, H. R. (2004). Simoncelli EP. Image quality assessment: from error visibility to structural similarity, *IEEE T Image Process.,* 13(4), 600-612.