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Mammogram Images Using Noise Removal of Filtering Techniques

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Abstract

Historically, image denoising methods were proposed for reducing salt and pepper noise in mammography images through enhanced filtering techniques. The Mammogram Image Analysis Society (MIAS) benchmark database for DICOM visuals is used to detect benign and malignant breast cancer. Thus, mean and median filtering techniques, as well as spatial filtering methods, are used to implement medical image analysis with the modalities of low and high radiation for medical images. Similar to these experimental and suggested techniques for removing salt and pepper noise, these statistical techniques assess MSE, SNR, and PSNR data for enhanced quality of signal in the image.

Keywords: *Mammogram Images, Medical Image Analysis (MIA), MSE, SNR and PSNR.*

1. Introduction

Breast cancer is the second deadliest disease, impacting one out of every eight women. Cancers are classified into two types: invasive ductal carcinoma and invasive lobular carcinoma. After menopause, women are at a higher risk of breast cancer. Diseases are a common occurrence among women. As a result, ultrasound, mammography, magnetic resonance imaging (MRI), and biopsy are the imaging tests. Fine-needle aspiration, core-needle biopsy, surgical, lymph node, and imaging guided biopsy are all options for biopsy. The effectiveness of digital mammography in identifying breast cancer is now being studied. Mammography images are to be a cornerstone in medical science. Even though the image output acquired during the X-ray scanning process is frequently a blueprint with unclear edges. Screen-film mammography has a limited ability to identify low contrast lesions in thick breasts. The MIAS database contains noise removal that are used in filtering techniques with mammogram images. The removal of noise is primarily accomplished by applying average filters, such as mean and median filters, to using experimental methods of mean squared error (MSE), signal-to-noise ratio (SNR) and peak to signal noise ratio (PSNR).

2. Review of Literature

Laurence Aroquiaraj (2013) [1] has proposed a hybrid soft computing method using mammography images with the database Mammography Image Analysis Society (MIAS) for diagnosing breast cancer. Robert, prewitt, sobel, and laplacian of gradient (LOG) operator edge detector are the suggested edge detection techniques. The edge detection algorithms used by these mammography pictures are fuzzy canny edge detector, fuzzy relative pixel edge detector, and fuzzy edge detection based on pixel gradient and standard deviation values (SDGD). For the performance analysis of several edge detection approaches, the objective statistical assessment methods are MSE, SNR, PSNR, and CII (Contrast Improved Index). Arda Mariya Joseph et al., (2017) [2] was mentioned that image processing with mammography is critical for the prevention of breast cancer detected through diagnostic tools. Digital mammography examines the low energy radiation of X-rays for human breast cancer. Mammogram images are evaluated, and the results and processing are extremely difficult to

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Vol. 02 Issue: 02 February 2024
Page No: 118 - 123
https://irjaeh.com

comprehend. Preprocessing approaches using filtering and denoising methods on mammography pictures result in a superior PSNR value comparison result. Noises that impact mammogram images include salt and pepper noise, gaussian noise, speckle noise, and Poisson noise. The wiener filter, gaussian filter, adaptive median filter, and hybrid median filter are employed as filtering methods. Finally, experimental results analysis of parameters such as PSNR and MSE with noise measurement. Bo Fu et al., (2018) [3], The picture's denoising approach is salt and pepper noise with various noise detection methods and strategies discussed. Image acquisition and transmission to high or low image quality. The images have maximum and minimum intensity values (0 or 255) for each pixel. Monochrome images have only one colour, but grayscale images have 8 bits per pixel with L=2k, where L is the number of levels shades of grey and k is the bits per pixel with k=8. The grey scale images have a L=28 resolution and an intensity of 256 grey scales. The proposed methodology adopts a flow chart approach to address noisy images by linking them to noisy identifiers through two methods: coordinates, where one represents noise-free pixels, and non-local switching means for noisy pixel coordinates. Additionally, the denoised image is obtained by connecting noisy images through patches using E-M clustering. The pixel coordinates (i,j) play a crucial role in both the noise model and the generative method categorization. Experimental approaches include the Adaptive Median Filter (AMF), Decision-Based Algorithm (DBA), Switching Non-Local Means (SNLM), Bundary Discrimination Noise Detection (BDND), and Modified Decision-Based Unsymmetric Trimmed Median Filter (MDBUTMF). The Peak Signal-to-Noise Ratio (PSNR) serves as an objective metric for evaluating denoising methods, measuring intensity. Shah Hemali et al. (2023) [4] have emphasized breast cancer as the second most perilous disease, emphasizing the importance of various identification modalities, including radiologist identification. The database for the MIAS (Mammogram Image Analysis System) is used for detection of cancer with a benchmark dataset with the performance of benign and malignant with dicom images. Preprocessing mammograms are different filters, like average, box, median, gaussian and bilateral filters with the techniques of image removal of denoising. The performance measures are MSE, SSIM and PSNR for the analysis of evaluating the measures for best results. Medical Imaging techniques are breast cancer diagnosis with variant techniques for cancer are digital mammography, breast ultrasound and breast MRI, biopsy and so on. The most important known is mammography is low cost to radiation of intensity and also low radiation of breast cancer identification to the early stage of cancer. The computer aided diagnostic (CAD) tools are image pre-processing, segmentation, feature extraction, feature selection and classification to the methods. And then image preprocessing is connected in three ways. That is cropping, denoising and image enhancement. With cropping are manual, automated and spatial filtering, and next denoising the transform domain filtering and CNN-based methods. Image enhancement is various methods for the spatial operators, transform operators and pseudo-coloring with different methods to the mammogram preprocessing techniques.

3. Denoising and Filtering Techniques in Mammogram Images

There are 322 images of mammograms from the MIAS (Mammogram Image Analysis Society) database, together with information on which tumors are benign or malignant. Through utilizing the gaussian noise, speckle noise, and salt and pepper noise denoising techniques for filtering. The images from mammograms make that noise significant. As a result, filtering approaches along with the gaussian, adaptive, and hybrid median filters along with the way those techniques are performed [2]. When identifying errors in diagnosis, mammography pictures are impacted by noise removal techniques such as mean, median filters and salt and pepper noise. Figure 1 Mammogram images of different filters with mdb001 of MIAS is explained. Figure 2 Mammogram images of different filters with mdb002 of MIAS is explained. Figure 3 and 4 Mammogram images of different filters with mdb003 of MIAS and MSE, SNR, and PSNR performance evaluations of the MIAS mammography images are shown in the

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 02 February 2024
Page No: 118 - 123
https://irjaeh.com

diagram [3].

3.1 Salt and Pepper Noise

Grayscale images commonly exhibit salt-and-pepper noise, where dark pixels appear in bright areas and bright pixels appear in dark areas. This noise is also referred to as impulse noise, arising from issues like dead pixels, errors during analog-to-digital conversion, and transmission errors in bits [4].

3.2 Gaussian Filters

Images are commonly processed to address issues such as blurring and noise using a Gaussian filter. Gaussian filters are known for their ability to minimize rise and fall times and prevent overshoot when applied to step function inputs. This characteristic is attributed to the minimal gathering latency associated with Gaussian filters. The Gaussian smoothing operator, which calculates a weighted average of neighbouring pixels based on the Gaussian distribution, is employed to mitigate Gaussian noise. This operator mimics the effects of a defocused lens and is effective in reducing noise in images [5-7].

3.3 Spatial Filters

$$\begin{matrix} F(x-1, y-1) & F(x-1, y) & F(x-1, y+1) \\ F(x, y-1) & F(x, y) & F(x, y+1) \\ F(X+1, y-1) & F(x+1, y) & F(x+1, y+1) \end{matrix} \quad (1)$$

The spatial filtering technique is applied directly to an image's pixels [8]. Typically, masks are thought to be larger in order to have a distinct centre pixel. The mask is positioned on the image so that its centre crosses every pixel in the image. Neighbourhood processing in spatial domain are three ways are low pass filtering, high pass filtering and median filtering to those techniques. The modify one pixel with value of neighbouring pixels are 3×3, 5×5 or 7×7 neighbourhood mask with the filtering methods [9]. Example of 3×3 mask equation (1) shown in the figure. Table 1 Performance analysis of different filters with mammogram images are given and explained.

3.3.1 Low Pass Filtering

The additional term for low pass filtering is smoothing filter. It eliminates the image's high-frequency components. An image can also be blurred with it. This is a low pass averaging filter mask [10-12]. Example of low pass Filtering equation (2) shown

$$\begin{matrix} 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \end{matrix} \quad (2)$$

3.3.2 High Pass Filtering

It removes low-frequency components while maintaining or improving high-frequency components. As displayed, a high pass filtering mask. Example of High pass Filtering equation (3) shown

$$\begin{matrix} -1/9 & -1/9 & -1/9 \\ -1/9 & 8/9 & -1/9 \\ -1/9 & -1/9 & -1/9 \end{matrix} \quad (3)$$

Nonlinear filtering is an alternative term for it. It is used to eliminate the whistling of salt and pepper. The pixel value is substituted with the median value of the nearby pixel in this case [13,14]. Filtering is a type of flexible and hybrid median filtering technique that the methods of non-linear spatial filter of various methods, one of which is hybrid median filter are two medians that are median of horizontal as well as vertical neighbor pixels, and another one is median of diagonal neighbor pixels [15].

Table 1 Performance analysis of different filters with mammogram images

	Mdb001	Mdb002	Mdb003
MSE	2.8453	2.8047	2.8421
SNR	4.0445	2.8952	2.8084
PSNR	12.0670	13.1615	13.1400

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Page No: 118 - 123
https://irjaeh.com

4. Experimental Analysis

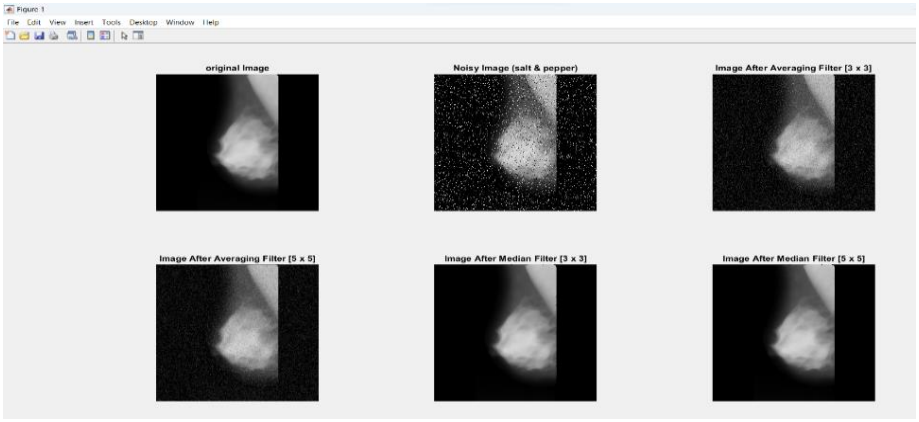

Figure 1 Mammogram images of different filters with mdb001 of MIAS

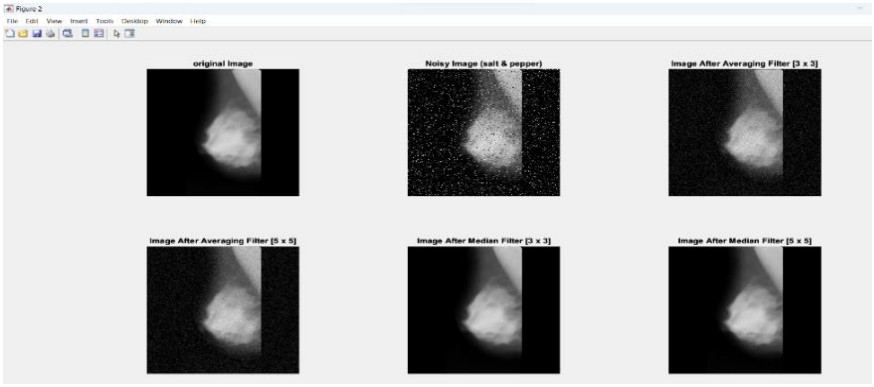

Figure 2 Mammogram images of different filters with mdb002 of MIAS

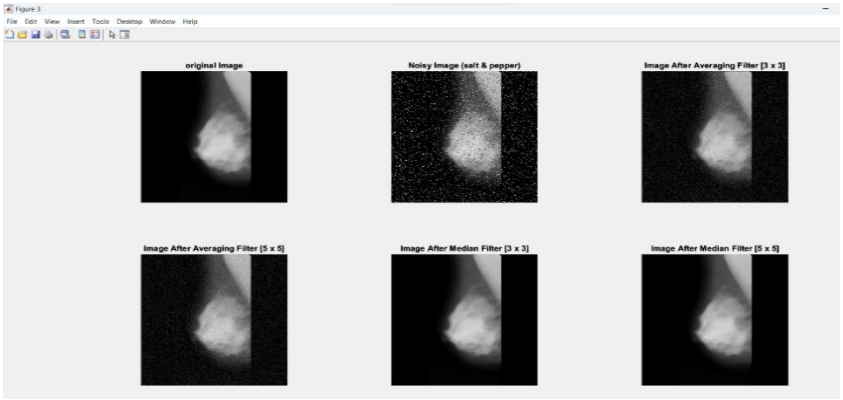

Figure 3 Mammogram images of different filters with mdb003 of MIAS

International Research Journal on Advanced Engineering Hub (IRJAEH)
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Page No: 118 - 123
https://irjaeh.com

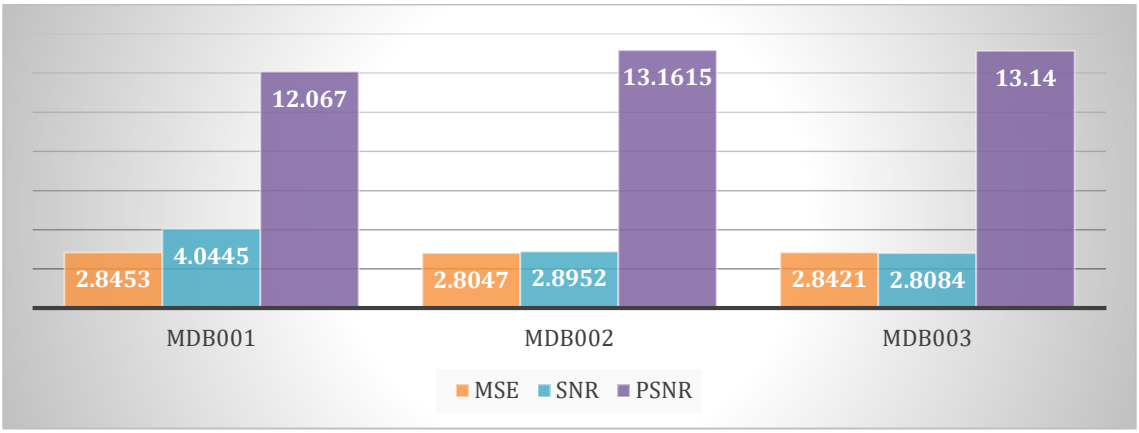

Figure 4 Show the results of the MSE, SNR, and PSNR performance evaluations of the MIAS mammography images.

Conclusion

This mammography study demonstrates the applicability of three distinct objective evaluation techniques: mean squared error (MSE), signal-to-noise ratio (SNR), and peak signal-to-noise ratio (PSNR) [16]. The experimental results indicate that employing strategies aimed at maximizing PSNR yields superior image quality, while low-level image quality is compromised by lossy compression. MSE quantifies the discrepancy between pixel values in the original and processed images, with a zero MSE indicating noise-free images [17-19]. SNR, measured in decibels, assesses the relationship between the signal and noise within a pixel. Consequently, the PSNR peak values of the three measures surpass those of the two evaluation methods for mammography image denoising and filtering techniques.

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