Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
Enhancing Connections in Visual and Performing Arts: Multidisciplinary Insights in Architecture and Planning
July-December 2023 4(2 ECVPAMIAP), 189–192

DESIGN AND DEVELOPMENT OF A SPECKLE REDUCTION METHOD FOR ENHANCED IMAGE QUALITY

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DOI 10.29121/shodhkosh.v4.i2 ECVPAMIAP.2023.6061

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Specal noise medical ultrasound makes images very little, making it difficult to make accurate diagnosis and analysis. This task offers a new way to improve images that combine wavelength threshing and particle herd optimization (PSO) to effectively reduce special noise, keeping important aspects of the image. The main goal is to create and improve a despecling method based on thresholding by choosing the best thresholding parameters "β" automatically to achieve the highest age headx (EPI). The suggested strategy has been tested on both synthetic and real -life liver ultrasonography dataset. First, synthetic images are given spotted noise with separate versions (0.01–0.2). Again, the logarithmic change and three-tier wavelet decomposition are performed with simulat 8. This study uses PSO to obtain the best "β" value using EPIs as a target function. Then, this study uses objective measures such as the average class error (MSE), signal-to-show ratio (SNR), peak signal-to-show ratio (PSNR), and EPI. The results suggest that the suggested method works better than specific depressing techniques including exponential thresholding, veneer filtering, mean filtering, SRAD, and standard wavelet danoizing. The visual comparison of both synthetic and clinical ultrasound shows that this method does a better job of getting rid of noise and keeping the edges sharp. The study also suggests a piece-defined ideal β value based on noise variance, which makes sufficient flexible to work with different amounts of noise. This task makes a powerful, flexible structure to reduce special noise. Its real -time medical image is important implications for growth systems, which can improve more accurate and automatic clinical analysis in a wide variety of healthcare contexts.

Keywords: Speckle Reduction, Image Quality, Edge Preservation Index, Particle Swarm Optimization

1. INTRODUCTION

Medical imaging, especially ultrasound, non-invasive, inexpensive and real time, is important to diagnose and monitor many health issues. Specal is caused by noise-altrasonic waves that reflect objects consistently-usually worsening ultrasound pictures (dirt-salutar et al., 2020; Hune et al., 2019). This noise obscures clinical information and makes physicians difficult to read. To improve ultrasound images and preserve the structural characteristics of minutes, excellent disappointing processes are required. Common noise filters such as the middle and veiner filters can only function and destroy important image areas (Choi and Jong, 2019; Bianco et al., 2018; Hune et al., 2019). Wavelet-based denoising and anisotropic diffusion models like SRAD are more advanced methods that balance noise reduction and feature preservation, although they still depend on parameter selection. Wavelet domain processing thresholding is a key component in denoising performance (Ma et al., 2018; Choi & Jeong, 2019).

Particle Swarm Optimization (PSO) is used to optimize a wavelet thresholding-based despeckling approach. The objective is to automatically determine the optimal thresholding value "β" for optimal edge preservation, as measured by the Edge Preservation Index (EPI). The work uses false and real liver ultrasound images to find a powerful and adaptable speckle noise reduction approach. The approach will improve medical images, making diagnosis more accurate and clinical imaging applications more automated. This section details this study's previous literature.

2. LITERATURE REVIEW

The subsequent Table 1 provides a more in-depth analysis of the previous literature about the speckle reduction method for enhanced image quality issue.

Table 1 Related Works

AUTHORS AND YEAR	METHODOLOGY	RESULTS AND DISCUSSION
Zhou et al., (2023)	A digital image correlation (DIC) method for speckle pattern quality assessment for deformation measurement is proposed.	Provided scores align with IC-GN algorithm measurement accuracy discrepancies for translation and tensile deformation.
Reddy et al., (2023)	A novel deep learning model, FCNN-IDOA, combines a Fundamental Convolutional Neural Network (FCNN) with an optimization algorithm. Our FCNN model builds on GoogLeNet and adds 15 layers for increased expressiveness.	The model achieved an average t(s) value of 84.764421, a PSNR of 66, an MSE of 54.9143, an RMSE of 0.491631, and a final t(s) of 83.759067.
Zhou et al., (2021)	Proposed model has two steps: 1) Cycle-Consistent GAN (CycleGAN) is trained to transfer style between two OCT image datasets from separate scanners.	The enhanced model outperformed our previous method and other state-of-the-art models in speckle noise removal, retinal structure preservation, and contrast enhancement.

2.1. RESEARCH GAP

While image denoising algorithms have improved, many still struggle to reconcile speckle noise removal with structural feature preservation, notably in ultrasonic pictures. Many approaches require manually given parameters, can't adjust to noise levels, and haven't been validated on clinical datasets. Using smart approaches like PSO to automate wavelet thresholding parameter improvement has also been neglected. This suggests greater research into creating a powerful, adaptable, and computationally efficient medical imaging despeckling framework.

3. METHODOLOGY

This study used both synthetic and actual databases to test our suggested method in this study. The fake photographs are first messed up by speckle noise, which can be between 0.01 and 0.2. Finding the best value for the thresholding parameter "β." The threshold value depends on the variable parameter "β." This study determined the best value for this option to keep as many edges as possible. When you use speckle reduction techniques, the picture frequently gets smoother, which means you lose some features. The Edge Preservation Index (EPI) tells you how well the edges of a processed picture are preserved. The noisy image and the reference photo are labelled as such. The EPI value might be anywhere from 0 to 1. The figure 1 below illustrates the schematic block diagram for selection of optimal value of the thresholding parameter 'β' in detail.

Figure 1

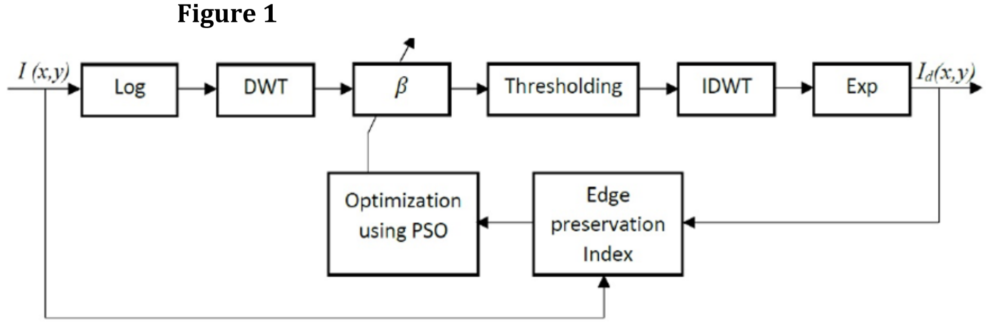

Figure 1 Schematic block diagram for selection of optimal value of the thresholding parameter 'β'.

4. RESULTS AND DISCUSSION

A thresholding function with the best thresholding parameter "β" is used on speckled test photographs to look at the qualitative performance of the suggested method. This study tests the suggested method by adding speckle noise with varying variances to the test photos and seeing how it works at different levels of noise. This study picked Symlet 8 as the mother wavelet for three-level wavelet decomposition. Because of this, the value of "β" can only change by 10. The PSO method starts by making a lot of random numbers for "β" in the range of 1 to 10. The value with the highest EPI value is picked. Then, this value of "β" is changed to one that has a higher EPI value. This study has added speckle noise with different levels of variation, and the ideal A thresholding component "B" value has been found for each image that is noisy. The index's value goes down when the noise dispersion goes up. For each background variance, the index and threshold value "H" values have been found for a number of test images.

There have also been comparisons of the performance metrics. Figure 2 shows a comparison of the performance metrics PSNR and EPI of the proposed method with those of current methods. The suggested methodology works better than other methods that have already been tested in the literature. This study compared the results of our suggested strategy to those of other well-known methods, such as exponential thresholding, wavelet denoising, the Wiener filter, the median filter, and the SRAD method, to make sure it worked.

Fiugre 2

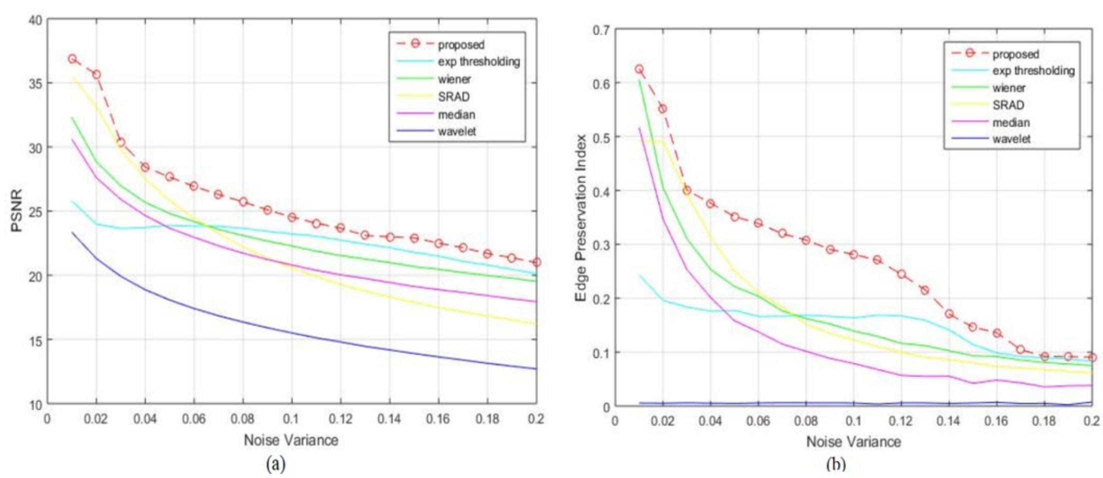

Figure 2 Comparison of (a) PSNR and (b) EPI performance parameters of the proposed technique with already existing techniques.

Comparing PSNR and EPI charts shows that the suggested method outperforms other noise variances. The suggested technique has greater PSNR and edge preservation consistency than Zhou et al. (2023), who assessed DIC speckle pattern quality, and Reddy et al. (2023), who employed hybrid deep learning for breast ultrasound denoising. Zhou et al. (2021) used cGANs for OCT denoising, although their model is less resilient to noise intensities. In contrast, the suggested method preserves denoising performance and structural integrity under increasing noise.

5. CONCLUSION

The suggested speckle reduction method, which was improved using the PSO and tested on both synthetic and clinical ultrasound paintings, beats existing methods in the context of PSNR and age system. Its flexibility to work with different levels of noise and its strength in keeping structural features make it a good candidate for dependable clinical picture enhancing applications.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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