iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 Issue: V Month of publication: May 2023

DOI: https://doi.org/10.22214/ijraset.2023.52672

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Speckle Noise Reduction in Ultrasound Images

Dr. S. Suryanarayana[1], A.Yashwanth Sai Varma[2], Harika Jinaga[3], K. Pranay Kumar[4]
[1]*Ph.d. Professor and HOD, Electronics and Communication Department, M. V. S. R Engineering College, Osmania University, Nadergul, Hyderabad, India*
[2, 3, 4]*Electronics and Communication, M. V. S. R. Enginnering College, Osmania University, Nadergul, Hyderabad, India*

Abstract: Ultrasound Imaging is used to examine various organs in the Human Body. However, in the process of obtaining a Ultrasound Image, Speckle noise is generated due to backscattered echo signals. So, a noise reduction method is required. To improve the speckle noise reduction, we propose a novel algorithm using characteristics of speckle noise and filtering methods based on Speckle Reducing Anisotropic Diffusion (SRAD) filtering, Discrete Wavelet Transform (DWT), Weighted Guided Image Filtering (WGIF) and Gradient Domain Guided Image Filtering (GDGIF). The SRAD filter is exploited as a preprocessing filter because it can be directly applied to a medical US image containing speckle noise without a log-compression. The wavelet domain has the advantage of suppressing the additive noise. Therefore, a homomorphic transformation is utilized to convert the multiplicative noise into additive noise. After two-level DWT decomposition is applied, to suppress the residual noise of an SRAD filtered image, GDGIF and WGIF are exploited to reduce noise from seven high-frequency subband images and one low-frequency sub-band image, respectively. Finally, a noise-free image is attained through inverse DWT and an exponential transform.
Keywords: Speckle, Homomorphic Transform, SRAD, WGIF, GDGIF.

I. INTRODUCTION

Ultrasound (US) imaging devices have been exploited to examine human bodies of various ages, from young to old people. In fact, US imaging is one of the most widely used imaging technologies in the medical diagnosis field. US imaging devices can be inexpensive, protected from radiation, and portable compared with other medical imaging devices such as X-ray imaging, computer tomography, magnetic resonance imaging, and positron emission tomography. Another advantage is that it can produce a real-time image. Based on these merits, US imaging devices are widely utilized to diagnose lesions in muscles, joints, blood vessels, and internal organs. US imaging is also used to examine fetuses of pregnant women, which can be viewed safely and in real time. Ultrasound waves are emitted by a transducer which also detects the ultrasound echo from the tissues. The active material used in the transducer is called a Piezoelectric material which is made of a special ceramic crystal. This material produces sound waves when an electric field is applied and can also work in reverse; that is, it can convert the sound waves back to electric field. When the transducer receives the echo, the electric signal is sent into an ultrasound scanner which generates two-dimensional images of organs and tissues and an Ultrasound image is produced. Speckle noise has the characteristics of multiplicative noise and additive noise, degrading the image resolution and contrast because of the granular pattern that appears in the images. Speckle noise in medical US images prevents physicians from performing accurate lesion diagnosis because they hinder the extraction, analysis, and recognition of lesion features. To gain a reliable lesion diagnosis and analysis through US imaging, a speckle noise suppression algorithm is an essential pre-processing technique. Various de-speckling algorithms were proposed but they were unable to reduce the halo crafts and preserve edges. Here we used SRAD (Speckle Reducing Anisotropic Filter), WGIF (Weighted guided image filtering), GDGIF (Gradient Domain Guided Image Filtering), DWT (Discrete wavelet transform) filters to reduce the halo crafts and preserve edges.

II. LITERATURE REVIEW

The literature review focuses on different techniques used for speckle noise reduction in ultrasound images. The first paper by Castro-Ospina and Duarte-Salazar provides an overview of classical methods such as spatial filtering, diffusion filtering, and wavelet filtering. The study emphasizes the importance of eliminating speckle noise in medical ultrasound images for improving metrological evaluation of biomedical applications [1]. The second paper by Choi and Jeong proposes a novel algorithm using characteristics of speckle noise and filtering methods such as SRAD filtering, DWT using symmetry characteristics, weighted guided image filtering, and GDGIF. The SRAD filter is used as a reprocessing mode. This paper presents a comprehensive approach for speckle noise reduction in ultrasound images [2].

The third paper by Jaybhay and Shastri discusses the removal of noise from ultrasound images using scalar filters and adaptive filters. The paper highlights the importance of preserving edge, shape, intensity value, and other important information in the image during the noise reduction process [3].The fourth paper by Kou, Chen, Wen, Li, and Shinqian focuses on the Guided Image Filter (GIF) which has edge preserving properties but may suffer from halo artifacts near some edges. This paper proposes the Gradient Domain guided image filtering which works effectively near the edges where halos are present [4]. The fifth paper by Li, Zheng, Zhu, Yao, and Wu proposes the Weighted Guided Image Filter which eliminates halo artifacts to a greater extent. The paper highlights the limitations of previously proposed techniques and presents a comprehensive approach for speckle noise reduction in ultrasound images [5]. In summary, the literature review presents a comprehensive overview of different techniques for speckle noise reduction in ultrasound images. The studies highlight the importance of preserving important information in the image while eliminating noise and propose novel algorithms and filters for effective speckle noise reduction.

III. REQUIREMENTS

1) *Matlab*
2) *Dataset*

Lenna (or Lena) is a standard test image used in the field of digital image processing starting in 1973, but it is no longer considered appropriate by some authors. It is a picture of the Swedish model Lena Forsén, shot by photographer Dwight Hooker, cropped from the centerfold of the November 1972 issue of *Playboy* magazine. The continued use of the image has attracted controversy, on both technical and social grounds, and many journals have discouraged or banned its use. Forsén herself has asked for the image to be retired.

3) *US-4 Dataset*

The US-4 is a dataset of Ultrasound (US) images. It is a video-based image dataset that contains over 23,000 high-resolution images from four US video sub-datasets, where two sub-datasets are newly collected by experienced doctors for this dataset.

4) *Ultrasound Image*

The images in the US-4 dataset are not totally compatible in the software used as it has very high resolution images. Hence, a normal ultrasound image with lower resolution has been used for better results.

IV. DESIGN

The noisy image is given as input to the algorithm where a SRAD (Speckle Reducing Anisotropic Diffusion Filter) filter is used as a pre-processing filter as it has amazing speckle noise reduction and feature preservation capabilities. As the Additive noise having characteristics of White Gaussian Noise can be eliminated easily in the Discrete Wavelet domain, homomorphic/logarithmic transform is used on the resulting SRAD image to convert the multiplicative noise to additive noise. The two-level wavelet decomposition converts the resulting image into seven high-frequency sub-band images and one low-frequency sub-band image. The wavelet coefficients in high-frequency are conserved and the additive noise is eliminated by using GDGIF (Gradient Domain Guided Image Filter). Meanwhile, the low-frequency sub-band image contains a large amount of speckle noise, WGIF (Weighted Guided Image Filter) or GIF (Guided Image Filter) is used to suppress the noise while conserving the edges in the image.

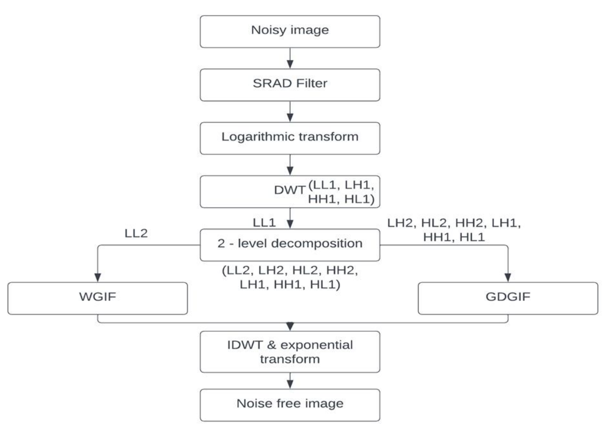


Fig. 1 shows the flowchart of the algorithm used for this project

Finally, a de-speckled image is obtained by using inverse discrete transform and exponential transform.

V. RESULT & DISCUSSION

By using the proposed algorithm, a noise free image can be obtained which preserves features better than existing methods and also supresses noise.

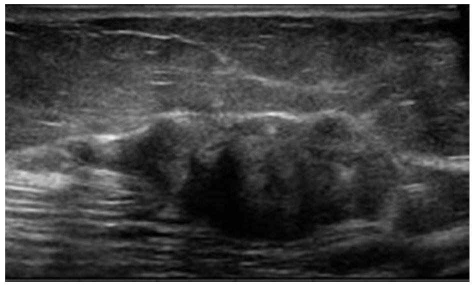


Fig. 2 shows the Ultrasound original image

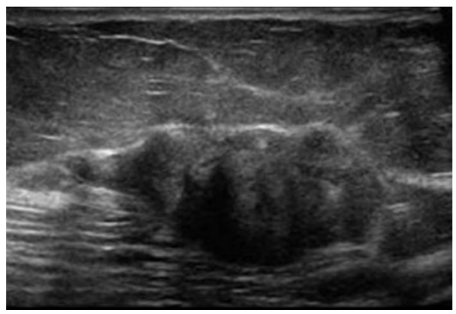


Fig. 3 shows the Ultrasound speckled image

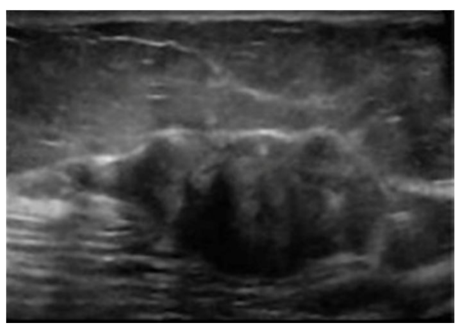


Fig. 4 shows the Ultrasound de-speckled image

The table below shows the metrics obtained using the proposed algorithm and compares these metrics to the existing methods or filters available. It can be observed that the metrics of the proposed algorithm are much better than the existing methods:

S.No	Filter	PSNR	SSIM	ENL
1.	Proposed Algorithm	29.91.1	0.8260	8.4726
2.	Lee Filter	18.5284	0.26359	8.4463
3.	Gaussian Filter	20.1139	0.43553	7.4139
4.	Frost Filter	20.7564	0.35784	7.1048

Table 1 shows the metrics compared to existing algorithms

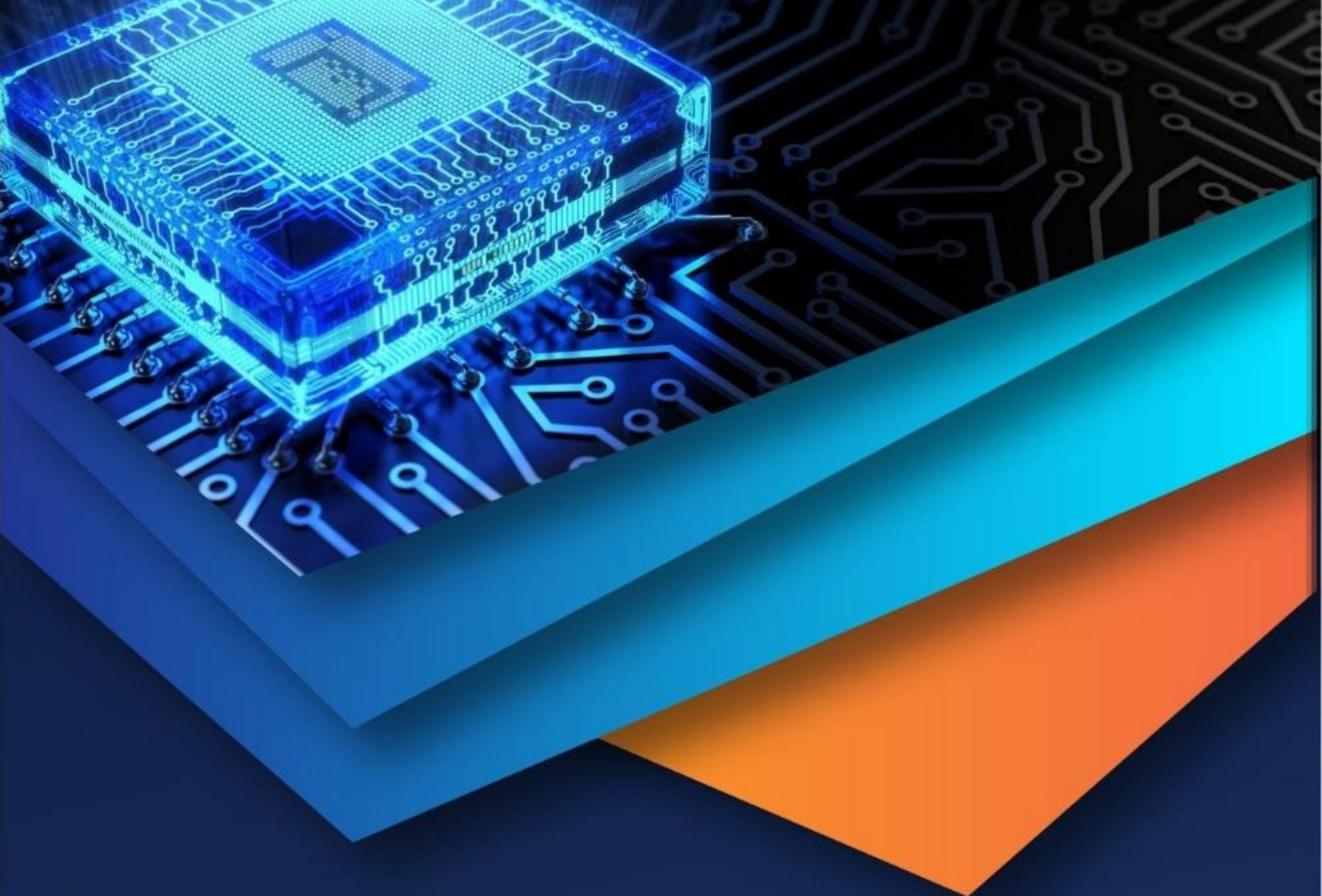
VI. CONCLUSION AND FUTURE SCOPE

In this project, we proposed an algorithm to reduce speckle noise in ultrasound images and conserve feature information in ultrasound images. To propose an algorithm for performing this task, we utilized the SRAD filter, DWT exhibiting symmetry characteristics, GDGIF, and WGIF. The speckle noise in the US images has two characteristics— multiplicative noise and additive noise. the SRAD filtering method can be applied to US images that contain speckle noise (multiplicative noise) because it can suppress the speckle noise and classify non-homogeneous regions. The SRAD filter was exploited as a preprocessing filter in the proposed algorithm. To suppress the additive noise in the wavelet domain efficiently, we utilized a homomorphic transformation to convert the multiplicative noise in the resulting image of the SRAD filter into additive noise. Then, two-level DWT based on symmetry characteristics was employed to decompose the resulting image into seven high-frequency sub-band images and one low-frequency sub-band image. To acquire noise-free images in the high-frequency sub-band images, the GDGIF was utilized to reduce the additive noise and retain edges. To remove artifacts and suppress the noise in the low-frequency sub-band image, we applied the WGIF to a low-frequency sub-band image. De-speckled image is formed using Wavelet reconstruction and exponential transform.

Future Scope of Speckle noise reduction is reassuring as it adapts different conventional as well as modern methods for reducing noises and preserving the features. Applying a combination of Image Processing and deep learning to enhance the performance of speckle noise suppression and edge conservation. Filtering is the most important process to reduce speckle noise. Several mechanisms are used in the filtering technique. Recently works are initiated for applying soft computing approaches with different filters to improve the performance of the filters. The main aim of the future research is to discover a new optimized filtering technique which effectively removes the speckle noise without destroying any features of the images such as edges, structure of the image etc. This technique will be easy to implement and will be faster in removing any type of speckle noise.

REFERENCES

[1] Speckle Noise Reduction in Ultrasound Images for Improving the Metrological Evaluation of Biomedical Applications: An Overview – IEEE
[2] Speckle Noise Reduction In Ultrasound Images - A review – IJERT
[3] Speckle noise reduction in Medical Ultrasound Imaging - https://www.intechopen.com/chapters/45101
[4] Andres Eduardo Castro-Ospina, Carlos A. Duarte-salazar “Speckle Noise Reduction in Ultrasound Images for Improving the Metrological Evaluation of Biomedical Applications: An Overview”, IEEE, 2022.
[5] Jyoti Jaybhay and Rajveer Shastri, “Signal and Image Processing: An international Journal(SIPJ)”, An International Journal (SPIJ) Vol.6, 2015.
[6] Kou , F.Chen , W.Wen, C.Li,S, “Gradient Domain guided image Filtering”, IEEE Transactions on Image Processing, 2015.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY