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Wavelet Decomposition Based Speckle Reduction Method for Liver Ultrasound Images by Using Hybrid median and Wavelet Filters Technique

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Abstract:

It is well-known that speckle is a multiplicative noise that degrades image quality and the visual evaluation in ultrasound imaging. This necessitates the need for robust despeckling techniques for both routine clinical practice and teleconsultation. Speckle noise in conventional radar results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element. It increases the mean grey level of a local area. The goal of this paper is to introduce the types of speckle noise reduction methods in liver ultrasound imaging , present a new hybrid technique of specle reduction and carry out a comparative evaluation framework of six despeckle filters with proposed method based on texture analysis, image quality evaluation metrics. The experimental result indicate that the proposed method is highly effective in improved speckle noise reduction as well as edges preserving results compared with those of existing methods.

Key words: Speckle noise, Ultrasound image, Despeckle filters, Imaging techniques, magnetic resonance imaging (MRI), positron emission tomography (PET) and Image quality.

I. Introduction

Medical imaging technology has experienced a dramatic change in the last 30 years. Previously, only X-ray radiographs were available, which showed the organs as shadows on a photographic film.

With the advent of modern computers and digital imaging technology, new imaging modalities like computer tomography (CT or computer-assisted tomography), magnetic resonance imaging (MRI), positron emission tomography (PET), and ultrasound, which deliver cross-sectional images of a patient's anatomy and physiology, have been developed. Among the imaging techniques employed are X-ray angiography, X-ray, CT, ultrasound imaging, MRI, PET, and single photon emission computer tomography. MRI and CT have advantages over ultrasound imaging in the sense that higher resolution and clearer images produced [1].

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Imaging techniques have long been used for assessing and treating cardiac and carotid disease [2, 3, 4]. Today's available imaging modalities produce a wide range of image data types for disease assessment, which include two-dimensional (2D) projection images, reconstructed three dimensional (3D) images, 2D slice images, true 3D images, time sequences of 2D and 3D images, and sequences of 2D interior view (endoluminal) images. The use of ultrasound in the diagnosis and the assessment of imaging organs and soft tissue structures, as well as human blood, is well established [5]. The primary goal of image optimization is to increase the ability to interpret information in an image for human viewers or to accurately extract useful features for machine learning-based algorithms. Various image enhancement techniques have been developed over the years to improve image quality, improve contrast, and preserve detail in the image [6].

In this paper we select appropriate method to despeckle an ultrasound image and applied the filters using wavelet decomposition and reconstruction.

II. Methodology

In order to analyze the amount of high frequency content in the image we used the two-dimensional discrete wavelet transform (dwt2) as provided in the MATLAB Wavelet toolbox. The dwt2 command produces four matrices of coefficients; the first contains the approximation coefficients, the second contains the wavelet coefficients along the horizontal, the third matrix contains the vertical wavelet coefficients, and the fourth contains the diagonal coefficients. The idwt2 will reconstruct the four matrices back to one image.

cA1≡ approximation coefficients
cH1≡horizental coefficients
cV1≡vertical coefficients
cD1≡diagonal coefficients

First step:-

Using Matlab, a series of filters which are linear scaling filter (DsFca), Geometric filter (DsFgf4d) , Homogenies filter (DsFhomog), Median filter (DsFmedian) , Total Variation (DsFtv) and Wavelet filter (DsFwaveltc) were chosen so as to specify which one is better in speckle noise enhancement.

Second step:-

Model Speckle noise using the Matlab on ultrasound image of liver is applied.

Third step:-

These series of chosen filters on the speckled ultrasound image of liver applied.

Fourth step:-

Five different quality measures applied between the original liver image (before applying the speckle noise) and after applying each of the filters specified before.

The quality measures are:

1. The MSE (Mean Square Error) which measures the quality change between the original and processed images in an $M \times N$ window. The MSE has been widely used to quantify image quality, and, when it is used alone, it does not correlate strongly enough with perceptual quality. It should use, therefore, together with other quality metrics and visual perception [6]. The root MSE (RMSE), which is the square root of the squared error averaged over an $M \times N$ window [7].
2. The error summation in the form of the Minkowski metric, which is the norm

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of the dissimilarity between the original and despeckled images.

3. SNR, although signal sensitivity and image noise properties are important by themselves, it is really their ratio that carries the most significance.
4. PSNR, it measures image fidelity, which is how closely the despeckled image resembles the original image [8].

Fifth step:-

The filter that is the best for despeckling ultrasound liver image chosen according to the quality measures.

Sixth step:-

Appropriate filter applied to the exact area of frequencies using discrete wavelet decomposition.

Block Diagram:-

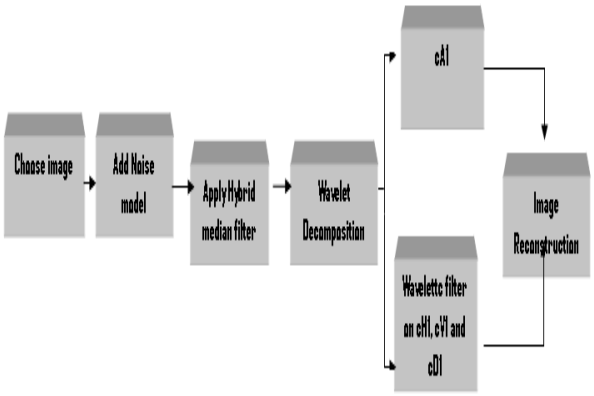


Figure 1: Block diagram of proposed method.

III. Results and discussion

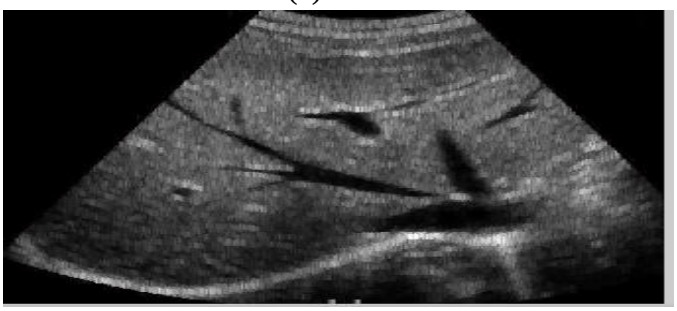
This is the results leading to combination of applying hybrid median filter then wavelet threshold after wavelet decomposition in the horizontal, diagonal and vertical coefficients in a speckled noise image of an ultrasound then reconstructing it back to its original form, the whole work was simulated using MATLAB 7.5.0 platform.

The comparison between various filters by usong two images of liver indicated in the table 1.

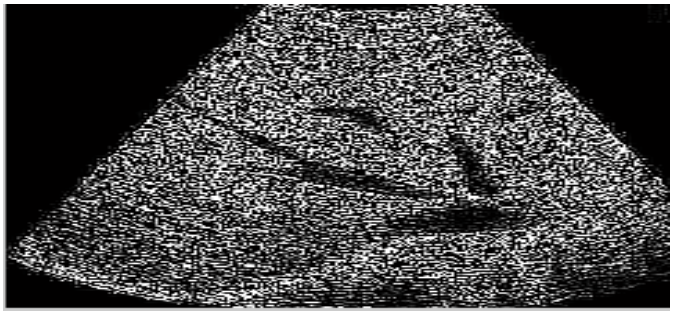
Table 1: The comparison between various filters using quality measures in liver image

Image 1	DsFca	DsFgf4d	DsFhomog	DsFmedian	DsFwaveltc	Total variation	Proposed Technique
MSE	0.0016	0.0104	0.0012	8.2638e-004	7.5405e-004	0.0023	6.9921e-004
Minkowski	0.0546	0.1371	0.0498	0.0402	0.0362	0.0678	0.0379
SNR	13.6696	5.5274	14.9363	16.5210	16.9188	12.1198	17.2467
PSNR	30.8844	22.7421	32.1511	33.7357	34.1335	29.3346	34.4614
RMSE	0.0399	0.1019	0.0345	0.0287	0.0275	0.0477	0.0264

(a)



(b)



(c)

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(d)

(e)

(f)

(g)

Figure 2: (a) DsFca (b)DsFgf4d (c)DsFhomog(d)DsFmedian (e)DsFwaveltc (f)DsFtv (g) Proposed Technique

The highlighted column in the Table 1 indicate that the proposed technique give the best results according to the quality measure.

The two steps are:-

1. Applying Hybrid median filter Before the wavelet decomposition.
2. After dividing the image into four by the wavelet decomposition (cA1,cH1,cV1,cD1), then we apply wavelet filter only to (cH1,cV1,cD1) for better results.

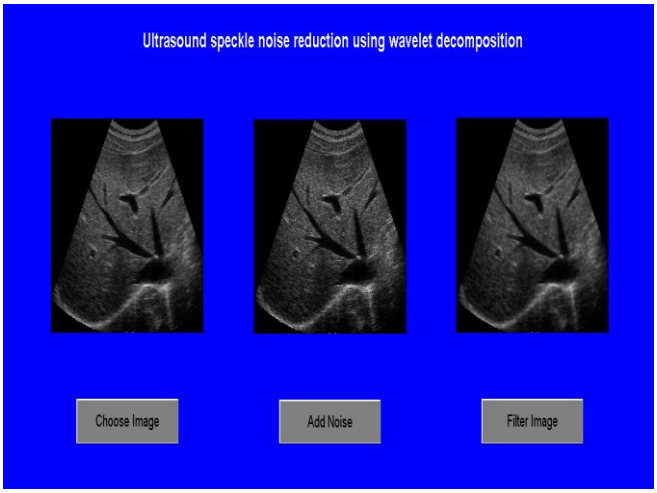

Figure 3: The Graphical user interface of proposed method

Conclusion

In conclusion, this research helps to despeckle an ultrasound image in a remarkable way using a combination of filters and wavelet decomposition giving us tremendous result in removing the speckle noise. The proposed method exhibits excellent despeckling performance in the flat areas and edge regions. The results of the images quality matrix analyses indicate that the proposed method outperforms the conventional methods.

References

[1] B. Fetics, E.Y. Wong, T. Murabarashi, G.S. Nelson, M.-M. Cohen, C.E. Rochitte, J.L.Weiss, D.A. Kass, E. Nevo, "Enhancement of contrast echocardiography by image variability analysis," *IEEE Trans. Med. Imaging*, vol. 20, no. 11, pp. 1123–1130, November 2001,doi:10.1109/42.963815.

[2] C.I. Christodoulou, C. Loizou, C.S. Pattichis, M. Pantziaris, E. Kyriakou, M.S.

Pattichis,C.N. Schizas, and A. Nicolaides,"Despeckle filtering in ultrasound imaging of the carotidartery," in *Second Joint EMBS/BMES Conference, Houston, TX*, vol. 2, pp. 1027–1028, October23–26, 2002.

[3] K. Abd-Elmoniem, A.-B. Youssef, and Y. Kadah, "Real-time speckle reduction and coherence enhancement in ultrasound imaging via nonlinear anisotropic diffusion," *IEEE Trans. Biomed.Eng*., vol. 49, no. 9, pp. 997–1014, Sept. 2002, doi:10.1109/TBME.2002.1028423.

[4] J.E. Wilhjelm, M.S. Jensen, S.K. Jespersen, B. Sahl, and E. Falk, "Visual and quantitative evaluation of selected image combination schemes in ultrasound spatial compound scanning," *IEEETrans. Med. Imaging*, vol. 23, no. 2, pp. 181–190, 2004, doi:10.1109/TMI.2003.822824.

[5] A. Achim, A. Bezerianos and P. Tsakalides, "Novel Bayesian multiscale method for speckle removal in medical ultrasound images," *IEEE Trans. Med. Imaging*, vol. 20, no. 8, pp. 772–783, 2001, doi:10.1109/42.938245.

[6] M. Waqar, A. Siddiq and I. Rasool, "A comparative study of medical image enhancement algorithms and quality assessment metrics on COVID=19 CT images," journal of signal image and video processing ,2022, http:// doi.org/10.1007/s11760-022-02214-2.

[7] Z. A. Mohammed, B. A. Abrahim, A.E. Omara, A.A. Mohammed, I.A .Hassan, and E.A. Mustafa, "Reduction of Speckle Noise and Image Enhancement in Ultrasound Image using Filtering Technique and Edge Detection," *Journal of Clinical Engineering*, vol. 45, no.1, pp.51–65, 2020.

[8] R. I. Elsharif, B. A. Abrahim, and Z.A. Mohammed, "Wavelet Decomposition Based Speckle Reduction Method for Ultrasound Images by Using Speckle-Reducing Anisotropic Diffusion and Hybrid Median," *Journal of Clinical Engineering*. Vol. 43, no.4, pp.163–170, 2018, DOI: 10.1097/ JCE.0000000000000300

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