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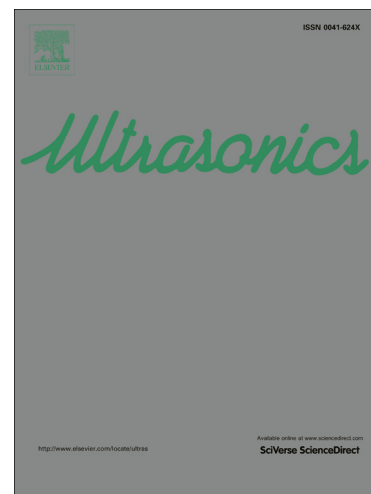
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# Speckle filtering of medical ultrasonic images using wavelet and guided filter

Ju Zhang<sup>a</sup>, Guangkuo Lin<sup>a</sup>, Lili Wu<sup>a</sup>, Yun Cheng<sup>b</sup>

<sup>a</sup> College of Information Engineering, Zhejiang University of Technology, Hangzhou China, 310023. zjk@zjut.edu.cn (Ju zhang), lgk\_zjut@163.com (Guangkuo Lin)

<sup>b</sup> Department of Ultrasound, Zhejiang Hospital, Hangzhou China, 310013. chengyun.zjhospital@gmail.com

**Abstract:** Speckle noise is an inherent yet ineffectual residual artifact in medical ultrasound images, which significantly degrades quality and restricts accuracy in automatic diagnostic techniques. Speckle reduction is therefore an important step prior to the analysis and processing of the ultrasound images. A new de-noising method based on an improved wavelet filter and guided filter is proposed in this paper. According to the characteristics of medical ultrasound images in the wavelet domain, an improved threshold function based on the universal wavelet threshold function is developed. The wavelet coefficients of speckle noise and noise-free signal are modeled as Rayleigh distribution and generalized Gaussian distribution respectively. The Bayesian maximum a posteriori estimation is applied to obtain a new wavelet shrinkage algorithm. The coefficients of the low frequency sub-band in the wavelet domain are filtered by guided filter. The filtered image is then obtained by using the inverse wavelet transformation. Experiments with the comparison of the other seven de-speckling filters are conducted. The results show that the proposed method not only has a strong de-speckling ability, but also keeps the image details, such as the edge of a lesion.

**Keywords:** medical ultrasound image; speckle noise; wavelet transformation; guided filter

## 1 Introduction

Ultrasonic imaging is a powerful technique for viewing the internal anatomy (e.g., abdomen, breast, liver, kidney, and musculoskeletal). It is non-invasive, non-radioactive, convenient and efficient compared with other medical diagnosis methods. Thus, the clinical application of ultrasonic imaging technology has become more important, especially in observing the growth status of the fetus in pregnant women and the diagnosis of lesions of the abdominal organs.

However, like all coherent imaging methods, ultrasonic imaging has a main disadvantage, i.e., it is contaminated by speckle noise. Speckle noise is generated by interaction of the reflected waves from various independent scatters within a cell resolution [1]. The existence of speckle noise has significantly degraded the quality of ultrasound images and restricted the development

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