A selective filter to smooth ultrasound images

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Ultrasound images are usually strongly affected by speckle noise, making hard the tasks of visual and computational analysis of the objects presented. Computational techniques to overcome the interference induced by this type of noise have been widely proposed [1, 2, 3, 4, 5, 6]. The speckle noise is more difficult to be smoothed than the additive noise, then some researchers have been adapting methods proposed for additive noise smoothing to process images affected by speckle noise, as Jin and Yang in [7] that proposed a variational model based on the work proposed by Rudin and collaborators [8] for additive noise smoothing. These methods use specific parameters that are usually defined for specific applications. The smoothing of ultrasound images is an area where these methods should be improved for denoising the original images without affecting the quality of information further extracted. In order to overcome the problem of smoothing ultrasound images of the female pelvic cavity, we propose a selective smoothing method for such images with the objective to perform a soft smoothing in the image regions representing the interesting borders. The pixels to be strongly or weakly smoothed are selected based in their radiation intensity [9]. The level of smoothing is controlled changing the convolution window size used for the average filtering calculation. From the tests that have been performed, we can conclude that if a pixel receives a positive radiance, the probability of this pixel belongs to an inner object region is high, so this pixel should be processed using an average filter with a bigger window. Several tests were performed using bladder ultrasound videos, and the results obtained revealed that the method is able to smooth successfully the input images, as can be seen in Fig. 1. In this figure, two image frames from two distinct ultrasound videos are shown together with the respective images filtered using the proposed method. The regions indicated by the white rectangles were manually chosen, taking into account their visually homogeneousity and the suitability to calculate the associated Equivalent Numbers of Looks (ENL) [10]. It should be noted that, a high ENL value indicates a good

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smoothing of the inner regions of the presented objects was achieved. In the next step of this work, we intend to perform a statistical analysis about the effects caused by the smoothing proposed method on the posterior image segmentation.

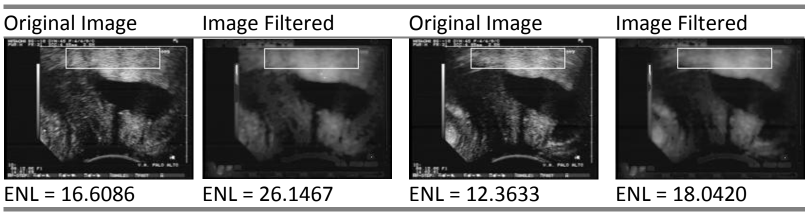

Fig. 1: Two original bladder ultrasound images and the correspondent images filtered using the proposed method and the ENL indices of the depicted regions.

Key words: image smoothing speckle noise, selective filter.

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