Blind Deconvolution and Denoising of Ultrasound Scans via Wavelet Shrinkage of the Log-Scalogram

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A novel technique for blind deconvolution and denoising of ultrasound scans is introduced. The target application is ultrasound imaging for non-destructive testing of multilayer material. Existing blind deconvolution techniques for ultrasound such as cepstrum-based methods and the work of Adam and Michailovich [1] – based on Discrete Wavelet Transform (DWT) shrinkage of the log-spectrum – exploit the smoothness of the pulse log-spectrum relative to the material reflectivity function to estimate the pulse. To reduce the effects of non-stationary behavior in the ultrasound signal on both the pulse spectrum estimation and deconvolution, the log-spectrum is localized with respect to time and represented as the Continuous Wavelet Transform (CWT) scalogram in the proposed technique. By applying DWT shrinkage to the log-scalogram, the pulse CWT coefficients are estimated and deconvolved by regularized wavelet-domain Wiener filtering. The reflectivity function is then recovered by inverse CWT. Parameters of the proposed technique are found by heuristic optimization on a subset of the scans. A variety of quality metrics – entropy, autocorrelation 6-dB width and fractal dimension – are used for training and their performance is discussed. The technique is further enhanced by using different CWT wavelets for the estimation and deconvolution, as suggested by the WienerChop method [2].

REFERENCES


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