Jordan University of Science and Technology

A two-step procedure for optimization of contrast sensitivity and specificity of post-beamforming Volterra filters

Authors: Mamoun F. Al-Mistarihi, Pornchai Phukpattaranont, and Emad S. Ebbini

Abstract: We previously introduced post-beamforming second order Volterra filters (SOVF) for decomposing the pulse-echo ultrasonic radiofrequency (RF) signal into its linear and quadratic components. Using singular value decomposition (SVD), an optimal algorithm for deriving the coefficients of the linear and quadratic kernels of the SOVF was developed and verified. Experimental results have shown that the quadratic kernel of the SOVF offers levels of sensitivity comparable to pulse inversion. However, the agent of the standard SVD-based quadratic kernel is sometimes compromised by sensitivity to nonlinear echoes from tissue. We present a two-step algorithm for computing the coefficients of the quadratic kernel leading to a reduction of tissue component and an increase in specificity while optimizing the sensitivity to the ultrasound contrast agents (UCA). In the first step, quadratic kernels from individual singular modes of the data matrix are compared in terms of their ability of maximize the contrast to tissue ratio (CTR). In the second step, quadratic kernels resulting in the highest CTR values are convolved. Experimental results from imaging of UCA in flow channels through tissue-mimicking phantoms and from in vivo data demonstrate the advantage of this two-step algorithm.