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Quadratic Pulse Inversion Ultrasonic Imaging (QPI): A Two-Step Procedure for Optimization of Contrast Sensitivity and Specificity

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Abstract: We have previously introduced an ultrasonic imaging approach that combines harmonic-sensitive pulse sequences with a post-beamforming quadratic kernel derived from a second-order Volterra filter (SOVF). This approach is designed to produce images with high sensitivity to nonlinear oscillations from microbubble ultrasound contrast agents (UCA) while maintaining high levels of noise rejection. In this paper, a two-step algorithm for computing the coefficients of the quadratic kernel leading to reduction of tissue component introduced by motion, maximizing the noise rejection and increases the specificity while optimizing the sensitivity to the UCA is presented. In the first step, quadratic kernels from individual singular modes of the PI 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. The imaging results indicate that a signal processing approach to this clinical challenge is feasible.