

Jordan University of Science and Technology

Quadratic Pulse Inversion Ultrasonic Imaging (QPI) Detection of Low-level Harmonic Activity of Microbubble Contrast Agents

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

Abstract: We present an ultrasonic imaging approach that combines harmonic-sensitive pulse sequences with a post-beamforming quadratic kernel derived from a 2nd-order Volterra filter (SOVF). This approach is designed to produce images with high sensitivity to nonlinear oscillations (20-30 dB below the fundamental) from microbubble ultrasound contrast agents (UCA) while maintaining high levels of noise rejection. In this paper, we demonstrate the performance of this approach with a pulse-inversion imaging sequence consisting of two transmit pulses with opposite polarity whose echoes are summed to enhance the even harmonics and suppress the fundamental. This is followed by an optimally designed SOVF-based quadratic kernel for further enhancing the harmonic signals, while maximizing the noise rejection. The approach is demonstrated experimentally using images from in vivo kidney after bolus injection with UCA. Imaging results, as well as the spectral contents of QPI data, show a significant increase in harmonic sensitivity and reduction in noise levels. Implications of this approach on new forms of functional ultrasound imaging are discussed.