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Complexity reduction of ultrasound sub-ultra-harmonic modeling by an input modified volterra approach

Fatima Sbeity, Sébastien Ménigot, Emma Kanbar, Nesrine HOUHAT, Jamal Charara, Jean-Marc Girault

Abstract: Contrast of echographic images has been highly improved by the injection of microbubbles, due to their nonlinear behavior. However, this contrast enhancement is limited by the nonlinear acoustic propagation in tissue. To overcome this drawback, sub and ultra-harmonic contrast imaging can be used, since only microbubbles can generate these components. Nonlinear modeling is a primordial step in the analysis of microbubble signals for sub and ultra-harmonic imaging. Nonlinear models like Volterra model has been applied in harmonic imaging to model harmonics optimally. However, it can model harmonics only. For sub and ultra-harmonic modeling, a multiple input single output (MISO) Volterra has been proposed. The aim of this study is to propose a simpler alternative for the modeling of sub and ultra-harmonics. We propose a modified single input single output (SMISO) Volterra model based on input demodulation. The model is tested using simulated and experimental signals. Results showed that sub and ultra-harmonics are modeled. The number of kernels is reduced to its half using SMISO model compared to MISO model. The relative mean square error between the simulated signal and the modeled signal with SMISO Volterra model is -15.8 dB and it is -60.7 dB for experimental signals. The computational time is reduced by a factor of 4 and 5 in simulated and experimental cases respectively. SMISO model can make easier the sub and ultra-harmonics modeling.

Keywords : Non lineaire acoustics, contrast enhancement