Multi-covariate Imaging of Sub-resolution Targets: Clinical Feasibility Study

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Background, Motivation and Objective

The use of spatial coherence in ultrasound beamforming has garnered much attention in the imaging literature. Many methods have been proposed, but generally employ *ad hoc* processing techniques only loosely based on the statistics of backscattered echoes. The van Cittert-Zernike (VCZ) theorem describes the spatial covariance of backscatter from diffuse targets. We have recently applied the VCZ theorem to a piecewise-stationary model of diffuse targets, and demonstrated the spatial covariance of the received echo data is the superposition of covariances from distinct spatial regions. Multi-covariate Imaging of Sub-resolution Targets (MIST) is an image formation method which estimates the contribution of each covariance component to the echo data covariance. Preliminary results have demonstrated MIST improves contrast-to-noise ratio (CNR) and speckle signal-to-noise ratio (SNR) while preserving resolution and native contrast in simulation and phantom acquisitions. While MIST has demonstrated promising initial results *in vivo*, it has not yet been evaluated over a large number of clinical datasets. The work presents a preliminary clinical evaluation of MIST in fetal imaging environments.

Statement of Contribution/Methods

Channel echo data of fetal targets were collected from 15 patient volunteers at the Duke University Fetal Diagnostic Center under an IRB-approved protocol. Data were collected using a Verasonics Vantage scanner and a C5-2V curvilinear array, as fundamental (2.4 MHz Tx/Rx) and pulse inversion harmonic (2.4 MHz Tx/4.8 MHz Rx) imaging modes. Conventional B-Mode and MIST images were formed and evaluated using contrast, CNR and speckle SNR. Regions of interest were chosen as regions of amniotic fluid and speckle-generating tissues around the transmit focal depth in the B-Mode images. Cine loops were acquired to evaluate the temporal stability of MIST.

Results/Discussion

MIST demonstrated improvements in all metrics relative to B-Mode across patients and acquisitions. Fundamental images (N=67) showed mean improvements of contrast by 43%, CNR by 50%, and speckle SNR by 36%. Harmonic images (N=152) showed mean improvements of contrast by 28%, CNR by 49%, and speckle SNR by 42%. Cine loops showed MIST to be temporally stable. These results demonstrate MIST is a clinically-viable imaging method capable of improving image quality across patients.