Two-dimensional spatial coherence for DMAS beamforming in multi-angle plane-wave imaging

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Background, Motivation and Objective

For plane-wave (PW) imaging, multi-angle coherent compounding uses simple summation in both transmit angle (TxEt) and receive channel (RxCh) dimensions of echo matrix to produce the image output. Previously, Delay-Multiply-and-Sum (DMAS) beamforming has been combined with multi-angle PW imaging but only in one dimension. In this study, a novel two-dimensional (2D) DMAS operation is proposed to extract the 2D spatial coherence of echo matrix for further improvement of image quality.

Statement of Contribution/Methods

For 2D-DMAS, each entry in the echo matrix is magnitude-scaled by p-th root while maintaining the phase. Then, the signal dimensionality is restored by p-th power after 2D summation. This paper compares the conventional coherent compounding (2D-DAS) with 2D-DMAS using PICMUS simulation and experimental data. Rx-DMAS and Tx-DMAS are also considered in which the spatial coherence is obtained in only RxCh and only TxEt dimension, respectively.

Results/Discussion

B-mode images in Fig (a)-(d) show that the 2D-DMAS exhibits significant improvement in image resolution and grating lobe level even when compared with Tx-DMAS and Rx-DMAS (LW: 2D-DAS, 0.53 mm; 2D-DMAS, 0.36 mm; Rx -DMAS, 0.44 mm; Tx-DMAS, 0.41 mm). Fig (e)-(h) also shows that 2D-DMAS is comparable to Rx-DMAS in suppression of clutter artifacts within the cyst (CR: 2D-DAS, -21.6 dB; 2D-DMAS, -37.0 dB; Rx-DMAS, -37.9 dB; Tx-DMAS, -28.7 dB). Nonetheless, similar to other DMAS counterparts, 2D-DMAS still exhibits a lower CNR than DAS due to the more granular speckle pattern.