Broadband Coherence Models for Improved MIST Depth of Field

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Background, Motivation and Objective

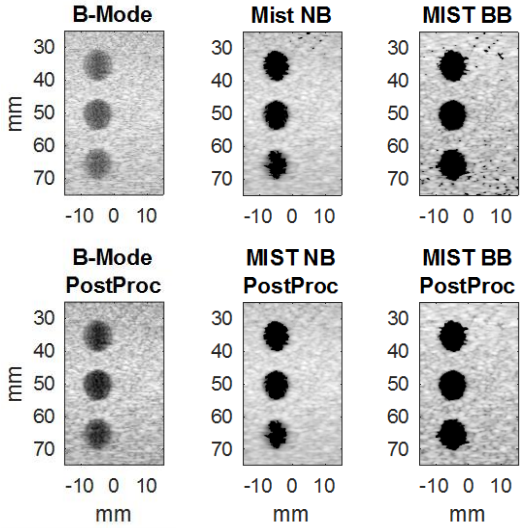
Our group has recently described MIST (Multi-covariance Imaging of Sub-resolution Targets) as an alternative to conventional beamforming. MIST fits the measured receive channel echo covariance to models of predicted echo covariance in order to improve image contrast and reduce speckle variability. Previously presented MIST results are degraded by a limited depth of field (DOF) which is characterized by a loss of spatial resolution and the presence of numerous dropout artifacts. Our goal in this work is to improve image resolution and reduce dropout artifacts across range.

Statement of Contribution/Methods

In this work we employ range-dependent broadband covariance models to improve resolution and non-linear post-processing to remove dropout artifacts. In the presented results, we use 100 FIELD II simulations to estimate broadband covariance matrices at each range in order to reconstruct MIST in a depth-dependent manner. We also employ the MATLAB `regionfill` command coupled with a 9-point medial filter in order to eliminate dropout artifacts. Image statistics were computed over regions of interest (ROIs) centered at the lesion centers with ROI diameters 80% of the simulated lesion diameters.

Results/Discussion

The presented images compare conventional B-Mode, fixed-focus (narrowband) MIST, and adaptive focus (broadband) MIST images; both with and without post processing. Narrowband MIST improves lesion contrast relative to B-Mode, but shows significant losses in spatial resolution. Broadband MIST improves lesion contrast relative to both B-Mode and narrowband MIST images. Narrowband MIST improves lesion contrast relative to B-Mode by roughly 15 dB in the nearfield, with broadband MIST achieving an additional 20 dB in contrast improvements in the far-field. Speckle SNR for both narrowband and broadband MIST is improved relative to B-Mode. We will also present fetal B-Mode, narrowband MIST, and broadband MIST images.



Lesion Contrast					
B-Mode	B-Mode PostProc	MIST-NB	MIST-NB PostProc	MIST-BB	MIST-BB PostProc
-25.5dB	-25.6dB	-41.5dB	-41.5dB	-41.0dB	-41.9dB
-31.7dB	-31.7dB	-42.8dB	-43.0dB	-57.4dB	-58.4dB
-24.0dB	-24.0dB	-27.9dB	-28.0dB	-48.4dB	-49.4dB

Speckle SNR					
B-Mode	B-Mode PostProc	MIST-NB	MIST-NB PostProc	MIST-BB	MIST-BB PostProc
1.93	2.30	2.97	3.20	3.10	3.48
1.84	2.21	2.72	2.95	2.50	2.72
1.81	2.06	2.54	2.69	2.01	2.22