AbstractID: 7145 Title: Ultrasound reflectivity imaging with a split-step Fourier propagator for cancer detection and diagnosis in heterogeneous breasts

Purpose: To improve resolution and reduce speckle in ultrasound breast images by accounting for ultrasound scattering from breast heterogeneities during reflectivity image reconstruction.

Method and Materials: X-ray mammography often fails to detect cancers in dense breasts, while breast ultrasound has the potential to detect them. Breast heterogeneities, particularly in dense breasts, generate significant ultrasound scattering. Properly handling ultrasound scattering is critical for reliable cancer detection and diagnosis in dense breasts. Ultrasound wave propagation in the breast is governed by the acoustic-wave equation in heterogeneous media, which can be decomposed into two one-way wave equations describing wave propagation in opposite directions. A split-step Fourier solution of a one-way wave equation is used for backpropagation of reflected ultrasound waves. The backpropagation consists of two steps: one phase-shift step in the frequency-wavenumber domain, and another phase-shift step in the frequency-space domain. During the backpropagation of ultrasound wavefields, heterogeneous breast sound-speed models obtained from transmission ultrasound tomography are used to approximately account for ultrasound wave scattering. The reflectivity imaging method based on the split-step Fourier propagator is applied to computer-generated ultrasound data and in-vivo ultrasound breast data acquired using a ring transducer array. The ultrasound images are compared with those obtained using a uniform sound-speed model.

Results: Comparison of ultrasound reflectivity images obtained using heterogeneous breast sound-speed models with those obtained with a uniform model shows that ultrasound scattering of breast heterogeneities needs to be taken into account to obtain high-resolution and high-quality breast images.

Conclusion: Using heterogeneous sound-speed models for ultrasound wave backpropagation during reflectivity image reconstruction significantly improves image resolution and reduces speckle. The resolution and quality of ultrasound reflectivity images are further enhanced with increasing accuracy and resolution of transmission ultrasound tomography.