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Frequency-Domain Synthetic Aperture Focusing Techniques for Imaging with Single-Element Focused Transducers

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The resolution of conventional single-element ultrasound imaging varies spatially and depends on several factors, such as the central frequency, bandwidth, and the transducer's active aperture size. Synthetic aperture focusing techniques (SAFT) enable dynamic focusing, which, among others, could lead to improvements in the spatial resolution of ultrasound imaging systems. In SAFT, a large effective aperture is mathematically synthesized by lateral scanning a single-element transducer. Several time-domain SAFT algorithms have been proposed for a single-element focused transducer. In this work, two new frequency-domain SAFT algorithms are proposed, which are based on matched filtering technique and taking into account the diffraction effects of a single-element transducer. The performance of the proposed SAFT algorithms is evaluated for single-element focused transducers with frequencies of 5 MHz, 25 MHz, and 55 MHz. The spatial resolution, signal-to-noise ratio (SNR) and contrast of the proposed frequency-domain SAFT algorithms are compared with conventional B-mode and time-domain SAFT using simulated and experimental data. Preliminary simulation results have shown that the proposed SAFT algorithms yield improved spatial resolution and SNR compared to conventional B-mode and time-domain SAFT. However, the contrasts of the proposed SAFT algorithms are similar to the conventional B-mode and time-domain SAFT.

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