Alternately tilted ultrasound transmission for high resolution B-mode image without compromise of frame rate

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Background, Motivation and Objective

Synthetic transmit aperture (STA), which enables to utilize broadened transmit energy of the focused beam for imaging, is now a new standard beamforming method for clinical ultrasound scanning. In ultrasound imaging, wider contribution of array elements provides better resolution imaging, and the STA beamforming can extend the contributed aperture range to all imaging points compared with conventional delay and sum (DAS) beamforming. However, the contributed aperture range of STA is still limited by the effective acoustic field of main lobe. This study proposes a method to extend the contributed aperture range over the limitation of conventional STA beamforming by designing the transmit beams. We aim to improve the lateral spatial resolution without degradation such as signal-to-noise ratio and frame rate.

Statement of Contribution/Methods

While in the conventional STA the beams are generally transmitted to perpendicular direction to the probe surface, in the proposed method the beams are deflected toward alternately different direction: the odd-numbered beams to the right and the even-numbered beams to the left, for example. These alternately deflected beams extend the contributed aperture to a certain imaging point even under the same transmitting energy of a beam. As is the case with the conventional STA, the received signals obtained by the beams are coherently summed up based on delay time calculation of virtual sound source model. We named this method to multi-angle STA (MASTA) beamforming. For the verification, we conducted Field II simulation and phantom experiments by the Verasonics Vantage 256. The data was acquired using the convex prove of 192 elements in both evaluations.

Results/Discussion

Fig. 1 shows experimental imaging results of the STA (a), the proposed MASTA (b), and lateral point spread functions (PSF) at the depth of 40 mm (c). In the MASTA, the side lobe appeared under the intensity of -20dB is largely decreased and the point targets can be observed clearly. The -30dB widths of the PSF were 4.4 mm and 2.4 mm at the STA and the MASTA, respectively. These results demonstrate that the proposed MASTA can provide better spatial resolution in comparison with the conventional STA beamforming.

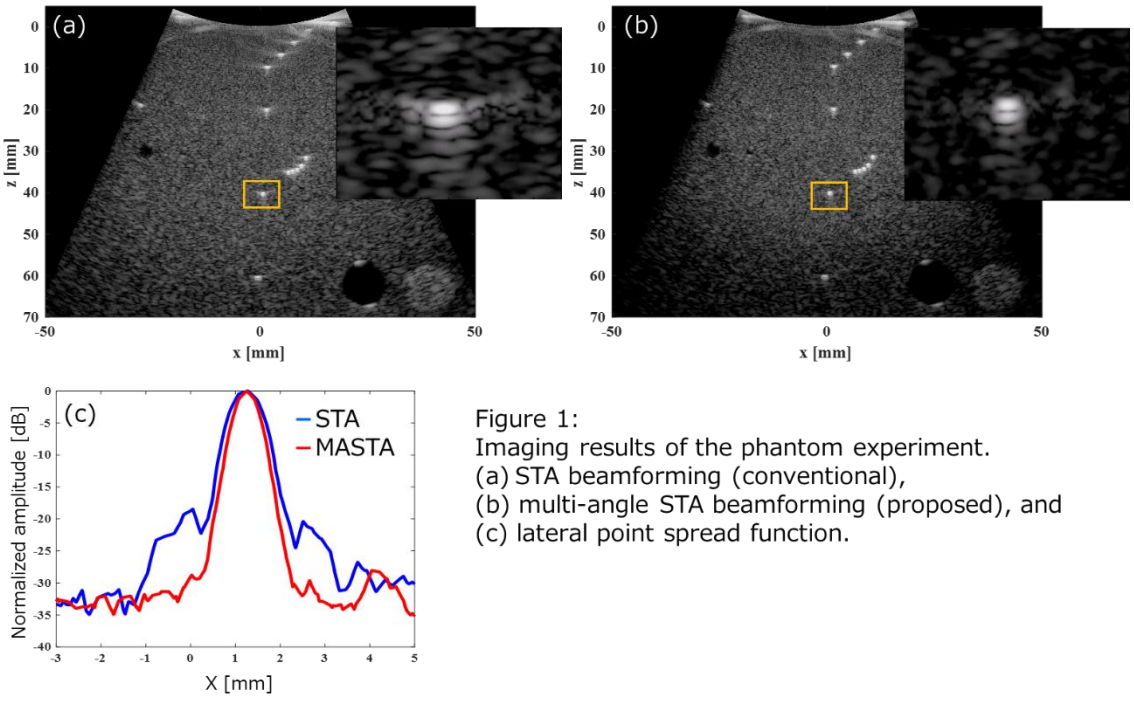

Figure 1:
Imaging results of the phantom experiment.
(a) STA beamforming (conventional),
(b) multi-angle STA beamforming (proposed), and
(c) lateral point spread function.