Resolving Ultrasound Contrast Microbubbles using Minimum Variance Beamforming - DTU Orbit (04/12/2018)

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Minimum Variance (MV) beamforming is known to improve the lateral resolution of ultrasound images and enhance the separation of isolated point scatterers. This paper aims to evaluate the adaptive beamformer's performance with flowing microbubbles (MBs), which are relevant to super-resolution ultrasound imaging. Simulations using point scatterer data from single emissions were complemented by an experimental investigation performed using a capillary tube phantom and the Synthetic Aperture Real-time Ultrasound System (SARUS). The MV performance was assessed by the minimum distance that allows the display of two scatterers positioned side-by-side, the lateral Full-Width-Half-Maximum (FWHM), and the Peak-Side-lobe-Level (PSL). In the tube, scatterer responses separated by down to 196 μm (or 1.05λ) were distinguished by the MV method, while the standard Delay-and-Sum (DAS) beamformers were unable to achieve such separation. Up to 9-fold FWHM decrease was also measured in favour of the MV beamformer, for individual echoes from MBs. The lateral distance between two scatterers impacted on their FWHM value, and additional differences in the scatterers’ axial or out-of-plane position also impacted on their size and appearance. The simulation and experimental results were in agreement in terms of lateral resolution. The point scatterer study showed that the proposed MV imaging scheme provided clear resolution benefits compared to DAS. Current super-resolution methods mainly depend on DAS beamformers. Instead, the use of the MV method may provide a larger number of detected, and potentially better localized, MB scatterers.

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