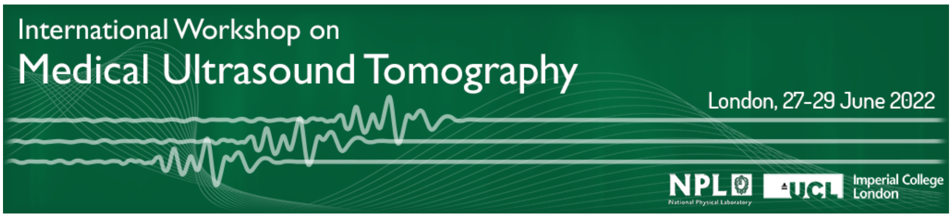

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Automatic aperture localization in free-hand multi-perspective ultrasound imaging

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The image quality in conventional reflection ultrasound is strongly restricted by the small aperture of the ultrasound transducer. This limits the field-of-view and angular coverage of image features. Full-view tomography systems solve this problem, but are generally limited to certain medical applications and anatomic sites.

An efficient tradeoff that increases the effective aperture but maintains the flexibility and cost efficiency of reflection ultrasound is multi-perspective ultrasound (MPUS). Here, two or more standard ultrasound transducers that partially surround the imaged region are combined by individually transmitting ultrasonic waves while all transducers receive on each transmit event (bistatic imaging).

We envision a future dual probe ultrasound system that allows for free-hand movement of one transducer while constantly registering and stitching the acquired volumes of both probes in space and time. However, to reconstruct bistatic image data, precise knowledge about the relative positions of the two probes is inevitable.

Approaches to apply probe localization based on image registration from different views are strongly impeded by speckle decorrelation and common image features can hardly be registered. It is, however, intuitive to believe that receive data of a wave that was transmitted by one and received by another probe contains information about the relative probe positions. Here, we present two different approaches to perform such a localization.

The first approach leverages redundancies in the Radon domain of receive data for different transmit angles in plane wave acquisitions. This is achieved by relating displacements in the Radon domain between different transmit angles to the relative probe position. The approach has been assessed for 2D data and achieved an accuracy of $2.5\pm1.1\lambda$ in a phantom study and an accuracy of $1.8\pm0.7\lambda$ in a simulation study in pure speckle.

The second approach relies on an optimization of coherence in the trans-probe image when approaching the correct relative position. We show that the problem converges nicely in 2D and discuss some challenges of the method in 3D. By including prior knowledge of the imaged geometry, we then show that this approach can achieve sub-wavelength accuracy in 3D simulation data ($0.66\pm0.17\lambda$). We see a great potential for this approach in free hand dual probe imaging, but also for large area, multi-aperture CMUT patches and for calibration of full-view tomography setups with rotating arrays.

Preferred Contribution Type

Presentation

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