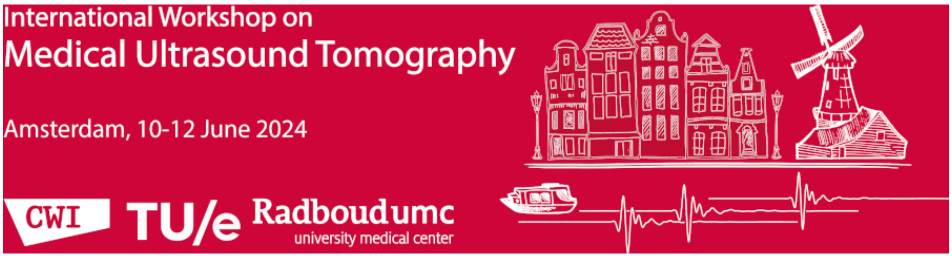

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Towards multiparameter full-waveform inversion for in-vivo ultrasound computed tomography

Monday, June 10, 2024 5:20 PM (15 minutes)

Full-waveform inversion (FWI) is a powerful reconstruction technique to generate high-resolution models of tissue and bone structure using non-invasive ultrasonic measurements. Sound-speed and reflectivity distributions within the tissue are reconstructed via an iterative data-fitting procedure that models the non-linear relationship between the ultrasonic wavefield and the model parameters. In previous work, we applied FWI to an in-vivo data set acquired with a tri-modal optoacoustic ultrasound imaging platform and reconstruct a high-resolution reflectivity model as well as the speed-of-sound and density distributions within the soft tissue. In this work, we aim to improve the specificity and sensitivity for differentiating between tissue types by additionally inverting for attenuation. Since waveform tomography critically relies on the availability of broadband signals, inverting for attenuation poses a greater challenge than inverting for sound speed or density. Therefore, in a first step towards a multiparameter waveform tomography including sound speed, density, and attenuation, we propose to augment FWI with an amplitude tomography framed as a linearized straight-ray problem. The corresponding linear forward problem expresses the mean attenuation coefficient along the propagation distance as the ratio of the amplitude spectrum of the first-arrival pulse through the previously reconstructed sound speed model and the background water model. The inverted attenuation distribution can then serve as a starting model for a full-waveform amplitude tomography. Because sound speed and attenuation contain complementary information to differentiate malignant masses, merging sound speed, reflection and attenuation images has been shown to visually enhance tumor regions. The fusion of detailed waveform tomography models therefore provides additional benefits in the resolution of speculated masses.

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