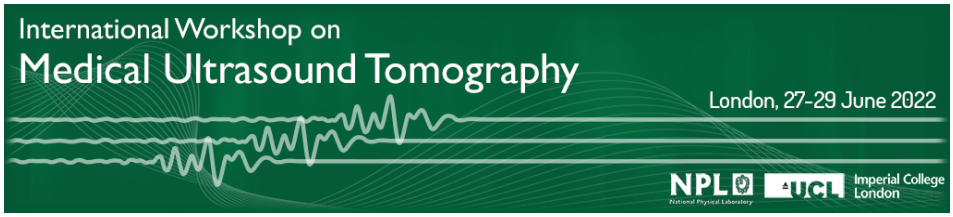

Contribution ID: **15** Type: **not specified**

Quantification of Speed-of-Sound with Preclinical Multimodal Transmission-Reflection Optoacoustic Ultrasound (TROPUS) system

Tuesday, June 28, 2022 2:20 PM (20 minutes)

Introduction
The multimodal transmission-reflection optoacoustic ultrasound (TROPUS) platform has been developed for multi-parametric detection and characterization of diseases in mouse models. The system consists of a circular transducer array (512 elements, 5 MHz) and provides coregistered images with multiple contrasts simultaneously, including multi-spectral optoacoustic tomography (MSOT), reflection ultrasound computed tomography (RUCT), and speed-of-sound using transmitted ultrasound waves (TUCT). In this work, we describe the speed of sound (SoS) reconstruction algorithm and rapid quantification of the SoS values obtained from the transmitted ultrasound (US) waves.

Methods
The transmitted US signals collected from 171 elements on the opposite side of each transmitting element of the TROPUS system are used to reconstruct quantitative SoS values of the tissues using a modified full-wave inversion (FWI) algorithm. The main challenge of the implementation is to enable rendering of quantitative reconstructions in a matter of minutes so that it can be used routinely. Reference waveforms are obtained from acquisitions in water (i.e. without any sample in the FOV). The signals obtained from the samples are decomposed as the sum of scaled and time-shifted versions of the reference waveforms, and the time-of-flight (TOF) for each emitter-receiver pair is obtained as the minimum of the time shifts obtained from this decomposition.

In the iterative image reconstruction process, the space between each US emitter and receiver is simultaneously sampled along multiple paths using a GPU code, and the computed TOF values are used to create estimated signals using the reference waveforms. Then, a conjugate gradient-descent algorithm is used to iteratively vary the SoS values in the defined image grid to minimize the mean-square error between the estimated waveforms and the actual measurements. This process is repeated until the cost function converges. Such a procedure requires less than 5 minutes per image slice.

Results/Discussion
As an example of a quantitative in-vivo study with TROPUS using SoS imaging, 4 NAFLD and 7 control mice were imaged. The livers were segmented using RUCT images, and SoS values of the liver were quantified in the TUCT images. As expected, the SoS decreased in NAFLD livers due to accumulation of lipids which are known to have lower SoS compared to healthy liver tissues (Figure 1).

Conclusions
SoS/TUCT images reconstructed with the proposed modified FWI algorithm provided quantitative results of lipid accumulation in a few minutes, indicating that the proposed approach is suitable for practical use in biomedical studies.

Preferred Contribution Type

Presentation

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