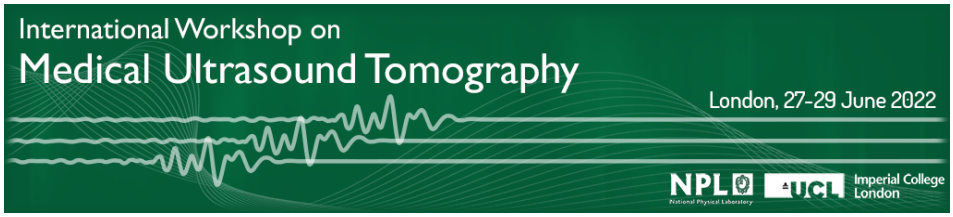

Contribution ID: **31** Type: **not specified**

Using uncertainty to estimate imaging errors induced by variable density, attenuation, and position

Tuesday, June 28, 2022 11:40 AM (20 minutes)

Ultrasound tomography relies on reconstruction algorithms which use approximate reconstruction physics. One promising example is full-waveform inversion (FWI), which can produce high-accuracy, high-resolution images of patient anatomy. Because the relationship between sound-speed and density is unknown, most FWI algorithms use an acoustic, constant-density approximation to simplify the inversion. Unfortunately, this approximation is emphatically untrue in the head, where the skull has a significantly higher density than surrounding tissues and supports elastic wave propagation. Failure to account for density and shear-mode propagation introduces artefacts into the reconstruction, but no reliable artefact detection methods exist. Instead, clinical practitioners are expected to identify and mitigate artefacts themselves.

To resolve this problem, we introduce a variance estimator into the reconstruction problem. The estimator is derived using a Gaussian approximation of the posterior (i.e the reconstruction) and stochastic variational inference. Despite the simplicity of the posterior approximation, the estimator is representative of image quality, requires less than 1% of the computational overhead, and needs no additional observational data compared to a mean-only image.

In this work, we also show that the estimator can identify artefacts induced by physics that violate the assumptions of the inversion algorithm. Figure 1(c) shows a constant-density FWI reconstruction of an in-silico dataset, where the in-silico dataset also adopts the constant-density approximation. Figure 1(d) shows the variance estimate is low when the reconstruction is correct. Figure 1(e) shows a constant-density FWI reconstruction of an in-silico dataset but, now, the dataset contains the density inhomogeneity shown in Figure 1(b). The failure of the constant-density approximation induces an artefact, and Figure 1(f) shows the variance estimate higher where artefact is located.

Preferred Contribution Type

Presentation

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