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Deep learning based sound speed image reconstruction in ultrasound tomography for breast cancer detection

Acoustic sound speed is an important bio-marker that can be used to characterize tissue types in the breast and differentiate between them.

The conventional way to obtain sound speed image is by using tomographic imaging methods. Higher resolution imaging uses non linear methods that range from ray-based travel time tomography to full-waveform inversion (FWI). Although the complexity varies, these methods have high to extremely high computational complexity and are time consuming.

In this work, we investigate a novel method based on a fully convolutional neural network to reconstruct sound speed images from raw data. This method is based on big-data training rather than physics based modelling and prior-knowledge as it is the case in conventional inversion methods. During the training stage in the deep learning method, the network learns to extract important features from the raw data and assembles them to more complex patterns by comparing it with ground truth data. Using this supervised learning techniques, a non linear projection from multiple shots of tomographic data to the corresponding sound speed images is established. During the prediction stage, the trained network can be used to estimate the sound speed images from the new input tomographic data.

A key characteristic of the deep-learning method is that it can generate a sound speed image without the need for having an initial sound speed map. Although the training of the deep neural networks is rather intensive, the application of the trained deep neural networks is nearly instant. Therefore, the computational time of sound speed estimation can be dramatically reduced.

By using numerical experiments on synthetic models, we can show promising initial results of the proposed method even when the input data are from more realistic scenarios.

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