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Ultrasound Aberration Correction for Layered Media

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Ultrasound diagnostics is an importatant, non-invasive examination method in modern medicine and the reconstruction of an observed object using its reflected ultrasound waves is an inverse problem of current scientific interest. With focused ultrasound waves, one can look deep inside the human body without causing harm. However, a crucial assumption in the theory of focused ultrasound imaging is that the sound speed in the observed medium is constant, which is not the case in most clinical applications. It is possible to incorporate different sound speeds into the model, but at the cost of significantly higher algorithmical and computational complexity, which makes them not applicable in clinical practice. In this talk, we present a mathematical framework for modelling the aberrations caused by a layered medium. Subsequently, by assuming the geometry of the observed object and the sound speed of its layers to be known, an aberration correction algorithm is discussed. In the usual setting of ultrasound tomography, these parameters are of course unknown and have to be calculated from the observed ultrasound data. But by analyzing the stability of this direct model, we can determine the necessary accuracy in an estimate for the unknown parameters and the resulting errors in the inverse problem of reconstruction. The effectiveness of the proposed method is shown through numerical simulation using the k-Wave toolbox for Matlab. This work is a collaboration with S. Hubmer (RICAM) and R. Ramlau (JKU).

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