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Model-based time reversal method for photoacoustic imaging of heterogeneous media

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In photoacoustic (also called optoacoustic or thermoacoustic) tomography acoustic pressure waves are generated by illumination of a semitransparent sample with pulsed electromagnetic radiation. Subsequently the waves propagate towards the detection surface enclosing the sample. The inverse problem consists of reconstructing the initial pressure sources from those measurements. In certain applications of photoacoustic imaging one has to deal with media with spatially varying sound velocity, e.g. bones in soft tissue. Image reconstruction without any compensation of this effect leads to a poor image quality. It is therefore essential to develop reconstruction algorithms that take spatially varying sound velocity into account and are able to reveal small structures in acoustically heterogeneous media.
A model-based time reversal reconstruction method is presented that is capable of reconstructing the initial pressure distribution despite variations of sound speed. This reconstruction method calculates the time reversed field directly with a second order embedded boundary method by retransmitting the measured pressure on the detector positions in reversed temporal order. Numerical simulations and experiments with phantoms consisting of areas with spatially varying sound velocity are presented.