

Time-Reversal Methods for Acousto-elastic Equations and Applications

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ABSTRACT

Time reversal (TR) is a subject of very active research. The principle is to take advantage of the reversibility of wave propagation phenomena, for example in acoustics, elastic or electromagnetism in an unknown medium, to back-propagate signals to the sources that emitted them. The initial experiment [1], was to refocus, very precisely, a recorded signal after passing through a barrier consisting of randomly distributed metal rods. Since then, numerous applications of this physical principle have been designed, for instance [2] and references therein. The first mathematical analysis can be found in [3] for a homogeneous medium and in [4], [5] for a random medium.

In a previous paper [6], we introduced a time-reversed method named TRAC (Time-Reversed Absorbing Conditions) for acoustic equation. This method enables one to recreate the past without knowing the location and the properties of the inclusion which diffracted the signals that are back-propagated. This was made possible by removing a small region surrounding the scattering inclusion.

In this paper, our aim is to extend our approach to elastodynamics equations. As the application we have in mind are concerned with ultrasound-based elasticity imaging methods, we rather consider a coupled acousto-elastic system of equations. We first derive the time-reversed method in homogeneous medium. We then extend our approach by considering inhomogeneous and dissipative media that we choose to be random. We stress that our method does not rely on any a priori knowledge of the physical properties of the inclusion. Hard, soft and penetrable inclusions are treated in the same way.

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