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Quantitative reconstruction of viscoelastic media with attenuation model uncertainty.

Florian Faucher & Otmar Scherzer.

We consider the inverse wave problem of reconstructing the properties of a viscoelastic medium. The data acquisition corresponds to probing waves that are sent and measured outside of the sample of interest, in the configuration of non-intrusive inversion. In media with attenuation, waves lose energy when propagating through the domain. Attenuation is a frequency-dependent phenomenon with several models existing [1], each leading to different models of wave equations. Therefore, in addition to adding unknown coefficients to the inverse problem, the attenuation law characterizing a medium is typically unknown prior to the reconstruction, hence further increasing the ill-posedness.

In this work, we consider time-harmonic waves which are convenient to unify the different models of attenuation using complex-valued parameters. We illustrate the difference in wave propagation depending on the attenuation law and carry out the reconstruction with attenuation model uncertainty [2]. That is, we perform the reconstruction procedure with different attenuation models used for the (synthetic) data generation and for the reconstruction. In this way, we show the robustness of the reconstruction method. Furthermore, we investigate a configuration with reflecting boundary surrounding the sample. To handle the resulting multiple reflections, we introduce a strategy of reconstruction with a progression of complex frequencies. We illustrate with experiments of ultrasound imaging.

[1] J.M. Carcione, *Wave Fields in Real Media: Wave Propagation in Anisotropic, Anelastic, Porous and Electromagnetic Media*, third ed., Elsevier, 2015.

[2] F. Faucher and O. Scherzer, Quantitative inverse problem in visco-acoustic media under attenuation model uncertainty, *Journal of Computational Physics*, 472 (2023), p. 111685, <https://doi.org/10.1016/j.jcp.2022.111685>