Viscoelastic modulus reconstruction using time harmonic vibrations

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Abstract. This paper presents a new iterative reconstruction method to provide high-resolution images of shear modulus and viscosity via the internal measurement of displacement fields in tissues. To solve the inverse problem, we compute the Fréchet derivatives of the least-squares discrepancy functional with respect to the shear modulus and shear viscosity. The proposed iterative reconstruction method using this Fréchet derivative does not require any differentiation of the displacement data for the full isotropic linearly viscoelastic model, whereas the standard reconstruction methods require at least double differentiation. Because the minimization problem is ill-posed and highly nonlinear, this adjoint-based optimization method needs a very well-matched initial guess. We find a good initial guess. For a well-matched initial guess, numerical experiments show that the proposed method considerably improves the quality of the reconstructed viscoelastic images.

1. Introduction

Elastography aims to provide a quantitative visualization of the mechanical properties of human tissues by using the relation between the wave propagation velocity and the mechanical properties of the tissues. The mechanical properties of tissue include the shear modulus, shear viscosity, and compression modulus. Quantification of the tissue shear modulus *in vivo* can provide evidence of the manifestation of tissue diseases.

Reference

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