Inexact interior-point methods for time-harmonic inverse medium problems

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Abstract

Parameter estimation from data measurements in spatially distributed models is of major interest in many areas of medical and engineering applications. Typically, the physical phenomenon under consideration is modeled by a PDE, which contains locally varying parameters. The inverse medium problem then consists in reconstructing the characteristics of the medium from partial (and often noisy) observations. Here we formulate the inverse medium problem as a PDE-constrained optimization problem, where the underlying wave field solves the (time-harmonic) Helmholtz equation. Ill-posedness is tackled through Tikhonov regularization. Furthermore, inequality constraints are used to encode prior knowledge to avoid many of the local minima (false solutions). The resulting optimization problem is large-scale, non-convex and the numerical solution of the PDE itself is but a fraction of the entire problem. We apply a primal-dual interior-point algorithm using inexact step computations. The usefulness of the method is demonstrated for a multi-layered inverse medium problem arising in seismic imaging.