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Solving Large-Scale Inverse Problems in Elasticity Using Sequential Quadratic Programming

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In this work we use a matrix-free trust-region sequential quadratic programming (SQP) algorithm to solve inverse problems governed by the partial differential equations (PDEs) of linear and nonlinear elasticity. SQP methods are based on the successive minimization of a quadratic model of the Lagrangian functional subject to a linear Taylor model of the PDE constraints. We derive first-order and second-order derivative operators that are necessary for an accurate and efficient implementation of these models in the context of elasticity equations.

The linear systems arising in our approach are related to convex quadratic programs that involve the model of the PDE constraints, but not the model of the Lagrangian functional. Such linear systems can be solved efficiently using preconditioners based on available iterative PDE solvers. The effectiveness of our approach is demonstrated through numerical examples in linear elastodynamics and nonlinear elastostatics.