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STRUCTURAL OPTIMIZATION USING CUTFEM

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We present shape and topology optimization procedures based on the cut finite element method (CutFEM) [1] where the set of admissible designs is described using level-sets.

For shape optimization [2, 3] the evolution of the domain is obtained by moving the level-set along a velocity field using a transport equation. We obtain a coupled problem involving three PDEs: (1) a linear elasticity problem; (2) an elliptic problem that determines the velocity field; (3) a transport problem for evolving the design.

The proposed topology optimization is level-set based and thus we have an exact representation of the domain boundary. This is in contrast to density based topology optimization where no such representation exists. We assume that the variation in pseudo-time of the level-set is proportional to the gradient (topological derivative) of a regularized objective function and we obtain a coupled problem involving two PDEs: (1) a linear elasticity problem; (2) a parabolic problem driven by the topological derivative of the objective function to evolve the design.

In both optimization procedures the elasticity problem is solved using a CutFEM on a fixed background mesh, completely avoiding remeshing as the domain is evolved. We also employ higher order cut approximations including isogeometric methods for the elasticity problem. To stabilize the method on the cut boundary, certain terms are added which provide the necessary control of the variation in the solution. We present numerical examples illustrating the behavior and performance of the optimization procedures.

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