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Topology Optimization of Geometrically Non-Linear Structures in the Deformed State

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Abstract

For geometrically non-linear structures the deformed configuration differs from the reference configuration. Classically the reference configuration is taken as the design domain leaving the deformed configuration to be the output of the optimization. In the presentation, topology optimization using the concept of inverse motion based form finding is used to optimize structures in its operating state. This approach provides the shape of the undeformed structure as part of the outcome of the analysis. The major difference in the inverse motion approach compared to the classical approach is that the inverse mapping of the deformation is used instead of the mapping from the reference configuration to the current configuration. The objective of the optimization is to find the stiffest structure for a given amount of material. The material model used is based on an isotropic polyconvex strain energy function. To overcome the difficulty of mesh sensitivity, the problem is regularized using a Helmholtz filter which is formulated in the deformed configuration. Both the mechanical balance equations and the filter PDE are solved using the finite element method. The presentation is closed by numerical examples which demonstrates the potential of the proposed formulation.