On third medium regularization in thermodynamic topology optimization

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Abstract

Topology optimization of hyperelastic structures is an ongoing challenge in which the numerical stability depends in particular on the regularization of the deformation of low-density elements. Void elements must not significantly influence the deformation of the entire structure due to their residual stiffness and should not tend to penetrate themselves in case of large distortions. Previous studies have repeatedly emphasized this aspect and have suggested various solutions. One of the latest approaches uses the stiffness of highly compressed void elements to implement a third-medium approach. Beside stability, this enables smooth contact within the formed structure. In the present work, a new third-medium approach based on linear shape functions is implemented in the thermodynamic topology optimization. The additional field variables, used for the regularization of the rotation of elements, are treated as additional degrees of freedom in Hamilton's principle. These variables are solved in their strong formulation of the related stationarity condition, using the Neighbored Element Method. The effect of the implemented third-medium approach will be present in various numerical results.

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