The Moving Node Approach in Topology Optimization

An Exploration to a Flow-inspired Meshless Method-based Topology Optimization Method

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ABSTRACT

In our research we explore the possibility of a flow-inspired meshless method-based topology optimization method. We investigate the possibility of using mass-containing nodes as design variables in topology optimization. Inspired by Lagrangian-based methods in fluid dynamics, we aim to explore the potential of changing the layout of a given structure by using mass-containing nodes. The design variable for the Lagrangian-based approach is not the density - as is the case in traditional topology optimization methods - but the nodal position. The topology optimization problem thereupon transforms into a flow-like problem, in which the material moves to a more optimal distribution.

In our work we introduce a basic Moving Node Approach (hereafter: MNA) topology optimization algorithm. We focus on the compliance minimization of the layout of two-dimensional linear elasticity problems, in which the equations have been discretized with meshless methods. In the MNA algorithm each mass node is accelerated along the compliance sensitivity in order to reach the optimal layout. Moreover, we introduce an asymptotic density function to prevent densities higher than one.

We can establish that in comparison to commercial software solutions, the results obtained with the MNA algorithm are in qualitative agreement. However, the MNA shows two interesting characteristics. First, the structural mass is almost completely conserved and this saves us from applying mass constraints. Second, only design variables exist in regions that contain material. In comparison to density-based optimization algorithms, this characteristic reduces the number of design variables. Moreover, the MNA is highly transparent and intuitive and allows for self-evident interaction with the flow as material can be added or removed simply by adding or removing mass nodes. Therefore it is a truly inviting approach that encourages experimental expansion.