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# Topology optimization using mesh-independent point-wise density interpolation

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**Abstract**

In conventional topology optimization methods based on material distribution concept, the description of the material density field relies on the finite element discretization, including the element type and node arrangement. In this paper, a novel topology optimization framework based on analysis mesh-separated density interpolation is introduced. Therein, the material distribution is described by an independent point-wise density interpolation (iPDI) using the density values of design variable points, which can be freely positioned within the design domain. By this means, the density field can be completely separated from the displacement field discretization. Moreover, the proposed material density interpolation scheme satisfies the [0, 1] range-restricted properties required by a strict and physically meaningful density interpolation. This method is shown to be free of numerical instabilities, mesh dependence and "islanding" phenomenon. It can also impose a certain size control effect on the optimized topologies.

This topology optimization formulation has also been extended to some particular problems. This formulation has also been extended to some particular problems. Firstly, adaptive density point refinement can be implemented for improving the resolution and quality of the topology optimization. Since the material density field description is separated from the analysis mesh, it is easy to refine the density point grid without remeshing the finite element model. Thus, the topology optimization can yield a desired high boundary resolution from a coarse initial mesh. Secondly, a combined topology description model of level sets and the point-wise material density field has been also proposed for the optimal design with embedded movable holes, as well as multiple components of specified geometries.

**References**

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