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Three-dimensional topology optimization via B-splines

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1. Abstract
This paper aims to demonstrate the computational advantages of B-spline based topology optimization for three-dimensional (3D) problems. Our B-spline based topology optimization is a SIMP based approach, where the density distribution is represented by B-splines over a rectangular domain. An arbitrarily shaped design domain is embedded into the B-spline domain. The density for analysis in the design domain is evaluated from the B-spline represented density distribution. In this approach, B-splines provide an intrinsic filter for density variables. This B-spline filter is very compact in storage since the usual storage size for a filter is of cubic order with respect to the filter size and is now reduced to linear order due to the tensor product nature of B-splines. This B-spline based approach completely decouples the design representation of density distribution from the finite element mesh thus multi-resolution designs can be obtained without re-meshing the design domain. We demonstrate these advantages for 3D problems where both re-meshing of design domain and storing the filtering information can be expensive. We also demonstrate it is very easy to extend for manufacturability such as minimum feature size and robustness.
2. Keywords: topology optimization, B-spline, filter, computational efficiency, robust formulation.