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Density Gradient Based Regularization of Topology Optimization Problems

Gregor Kotucha, Klaus Hackl

University of Bochum, Institute of Mechanics, Germany

The discretization of topology design problems on the basis of the finite-element-method results in general in large-scale combinatorial optimization problems, which are usually relaxed by the introduction of a continuous material density function as design variable. In this context special penalty methods such as the SIMP-approach are used to reduce the set of admissible solutions to so-called black&white designs free of gray regions characterized by intermediate density values. Nevertheless the penalization of intermediate densities results in discontinuities in the global density distribution and often leads to unfavourable microstructures such as the well-known checkerboard patterns. To obtain black&white designs free of microstructures we regularize the optimization problem by introducing a global penalty functional based on the gradient of the density function. Furthermore we discuss numerical aspects of the proposed regularization such as the implementation of the penalty functional into the SIMP-model, the formulation of the corresponding stiffness-matrix, the sensitivity analysis and the numerical solution of the regularized problem.

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