Structural Optimization Through Anisotropic Mesh Adaptation

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ABSTRACT

Structural optimization is a class of engineering problems whose final goal is to identify the optimal design of a structure with respect to a chosen objective functional. In this context, shape (SO) and topology optimization (TO) are two viable techniques to design new and performing structures [1, 2]. From a mathematical viewpoint, SO and TO differ in the features guaranteed to the final optimized layout in a complementary way, still pursuing the same objective (e.g., maximize the stiffness of the structure or the fundamental frequency in the dynamic case). Shape optimization consists in moving the structure boundary while preserving the topology of the initial configuration; on the contrary, topology optimization yields an optimized structure characterized by a new topology, preserving the initial shape of the domain.

In this presentation, we consider the shape and the topology optimization of a continuum medium in the linear elastic regime, and we set the minimization of the static compliance as the objective functional, being equivalent to the maximization of the stiffness of the body. For the SO model, an additional design constraint to enforce the mass preservation is imposed. The resulting structure enjoys a reduction of the objective functional while no modification of the total mass and of the topology occurs. On the contrary, for the topology optimization problem, we impose a mass reduction constraint so that the final structure, changed in the topology, is lighter. The model that we adopt for TO relies on a standard SIMP formulation to identify the optimal allocation of void and material in the computational domain. The finite element discretization is performed on ad-hoc tailored meshes which are anisotropically adapted to the structure boundary. The adapted meshes are generated via a metric-based procedure, driven by an *a posteriori* error estimator [3]. As a consequence, the optimized topology is sharply described and the final structure presents a clear-cut interface between void and solid, without any surface roughness due to a coarse discretization.

After introducing shape and topology optimization as two independent techniques for structural optimization, we propose a sequential combination of SO with TO, with the aim of obtaining lightweight and stiff structures [4]. A final quantitative analysis is provided, highlighting the mechanical performances of the new configurations.

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