Topology Optimization Assisted by Mesh Adaptation: Motivation and Numerical Validation

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ABSTRACT

As new manufacturing technologies (such as Additive Layer Manufacturing - ALM) are increasingly becoming popular and exploited in several engineering fields, a new paradigm for designing structures is requested ([1, 2]). ALM, for instance, allows the realization of objects without many of the geometrical and manufacturability constraints imposed by traditional techniques. In this view, a freeform approach for structural design can be successfully employed.

This need can be addressed, in a mathematical context, via the widespread Topology Optimization technique. The main idea behind it is to optimize the material distribution inside a computational domain in order to meet some constraints, while searching for the minima (or maxima) of an objective function of interest (e.g., static compliance, displacements).

One of the most employed model is the SIMP (see [3]), a density-based approach in which the final outcome is the material distribution, a suitable variable ρ, identifying where the material is located. The optimized solution yielded by such a technique shows particular features: e.g., ρ is mesh-dependent and presents high gradients in correspondence with the boundaries of the structure (i.e., the void-material interface). For these reasons, in our view, the classical formulation of the algorithm can be enriched with the choice of an optimal computational grid. As a result, even geometrically complex structures can be expected as the outcome of a computationally affordable simulation.

In this communication, we aim at presenting the algorithm we developed which combines the SIMP classical approach with a metric-based mesh adaptation procedure. We analyze the results obtained with such a tool in comparison with those delivered by commercial softwares, we provide the computational resources needed and we present the possible perspectives.

REFERENCES

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