A POD framework for topology optimization on anisotropic adapted meshes

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ABSTRACT

Structural optimization aims at designing an optimal configuration that maximizes or minimizes given target performances while guaranteeing required specifics. In this class, topology optimization finds the optimal allocation of material inside an initial design domain by modifying the topology [1]. Numerical simulations are strongly affected by the adopted discretization in terms of convergence of the employed algorithms, quality of the numerical outcomes, and required computational burden. Hence, the choice of a proper numerical scheme may be of crucial importance, especially in a 3D setting.

Reduced order models may assist the topology optimization process as they allow for a reduction of the dimension of the discrete space and, consequently, of the computational burden. To this end, we employ the Proper Orthogonal Decomposition (POD) paradigm to discretize a parametrized topology optimization problem. We distinguish two steps: in the offline phase, we collect high-fidelity finite element solutions to the topology optimization problem for some sampled values of the parameter of interest; in the online phase, the high-fidelity information is compressed into a small-sized basis to predict the solution of a topology optimization problem associated with a value of the parameter not yet sampled [2].

This approach considerably reduces the computational time with respect to a standard high fidelity simulation and promotes a stable and fast convergence. Nevertheless, the obtained configurations are suboptimal in terms of the target performances and successive post-processing may be needed to finalize the ultimate layout. Here we propose a predictor-corrector approach, by using the POD-reduced topology optimization to predict a rough design which is then improved by a correction step, e.g., by means of a full-space topology optimization problem coupled with anisotropic mesh adaptation [3]. This two-step procedure allows us to quickly deliver fine-tuned optimized structures, which retain competitive target performances compared with standard state-of-the-art algorithms.

REFERENCES