A POD-based technique for topology optimization

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ABSTRACT

Structural topology optimization is employed to design an optimal material/void distribution so that the new topology fulfills given constraints and maximizes/minimizes desired properties. Several methods are available in the literature, including level set, phase-field and density-based models [1]. The corresponding numerical approaches are considerably affected by the discretization adopted for the physical domain, in particular in terms of convergence of the algorithms and required computational time. This issue turns out to be crucial, especially when dealing with complex 3D geometries.

In this regard, reduced order models play an important role, since conceived to reduce the dimension of the discrete space. In this presentation, we apply Proper Orthogonal Decomposition (POD) to a parametrized version of the topology optimization problem. According to a standard offline/online paradigm, in the offline phase we collect (high-fidelity) solutions to the parametrized topology optimization problem, framed in a standard discrete space and corresponding to sampled values of the parameters. In the online phase, we extract the reduced basis to predict the optimal design for any new choice of the parameters [2]. This first attempt yields a considerable speed-up in terms of computational time and significantly reduces the number of iterations required for convergence. Nevertheless, the predicted optimized structures are often characterized by worse performances with respect to the ones provided by the corresponding high-fidelity solutions. To overcome this limit, we have settled a predictor-corrector procedure, where the POD approach is employed for the prediction while the correction is performed via a standard topology optimization problem coupled with anisotropic mesh adaptation [3]. This combined approach leads, in a limited timespan, to structures characterized by good performances and, additionally, by a high smoothness, thanks to the employment of ad-hoc tailored computational grids.

REFERENCES

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