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On the fly construction of reduced order models for topology optimization

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Abstract

One of the major contributors to the computational cost of topology optimization is the cost of solving the equilibrium equations at each iteration. The construction of reduced order models by projection, also known as reduced basis models, is a possible way for mitigating this cost. It involves solving the system of equilibrium equations projected on a certain basis, which drastically reduces the computational cost especially for large scale problems. Such a method has been proposed in [1] for the efficient construction of surrogate models and inspired the approach proposed here for topology optimization.

A new method for coupling reduced basis models with topology optimization is thus proposed to reduce the cost of topology optimization of large scale problems. The novel approach consists in constructing the reduced basis on the fly, based on previously calculated solutions of the equilibrium equations. At each step of the topology optimization a reduced basis solution is first computed. The full solution is only calculated if the reduced basis solution is not accurate enough, in which case the full solution is also used to update the reduced basis. The reduced basis is thus adaptively constructed and enriched, based on the convergence behavior of the topology optimization. A variation of this approach is also possible with adjusted sensitivities using a similar methodology to the one developed in [2].

The proposed approach is illustrated on 2D and 3D minimum compliance topology optimization benchmark problems: the 2D MBB and 3D wheel problems. Computational cost savings by up to a factor of 12 were achieved on these problems and the savings have been shown to increase with the size of the problem. A detailed description of the proposed topology optimization framework, as well as further results, comparison and trade-off studies can be found in [3].

References

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