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EFFICIENT MULTILEVEL SOLUTION OF TOPOLOGY OPTIMIZATION PROBLEMS WITH EIGENVALUES

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Abstract: Topology optimization involving eigenvalues is addressed and an efficient method for the solution of large scale problems is proposed. Eigenvalue problems are classically encountered in structural optimization, either as objectives or behavioral constraints, as vibration or stability requirements have to be introduced in the design. Despite the impressive development of topology optimization, both in methods and applications, the repeated solution of eigenvalue problems in a large scale optimization setting still presents severe challenges. We propose an alternative optimization problem, based on the minimization of a measure of the structural compliance and which can be effectively adopted as a surrogate method for optimizing the eigenvalue-related structural responses [P1]. Associated with such objective function is a linear state problem, essentially a frequency response problem, which can be solved extremely efficiently by using preconditioned iterative methods. For this we use a multilevel strategy both for computing the parameters defining the linear frequency response problem and for actually solving it [P2]. A full eigenvalue analysis is performed only on a coarse scale, and the modes are projected on the fine scale, where the optimization problem is set up and the frequency response is solved. The overall procedure leads to an optimal (linear) scaling of the computational cost, conceptually making eigenvalue topology optimization as cheap as a simple compliance-based one. The procedure also allows the computation of useful upper and lower bounds to the fine scale eigenvalues. Applications concerning topology optimization for free vibrations and buckling loads, for both 2D and 3D structures are presented. Besides discussing computational savings, the performance of the multilevel frequency response is examined for situations where eigenvalues coalescing occurs, evidently mesh dependent problems are studied, or spurious localized modes are prone to appear.

References

[P1]Andreassen E., Ferrari F., Sigmund O., Diaz A. - Frequency response as a surrogate eigenvalue problem in topology optimization, International Journal for Numerical Methods in Engineering, Vol. 113, Issue 8, pp. 1214—1229

[P2 Ferrari F., Lazarov B. S., Sigmund O - Eigenvalue topology optimization via efficient multilevel solution of the Frequency Response, Submitted