

MODEL ORDER REDUCTION TECHNIQUES FOR FAST TOPOLOGY OPTIMIZATION OF BROADBAND VIBROACOUSTIC SYSTEMS

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Abstract

Topology optimization is the act of optimizing an object or part of objects' structure to achieve desirable physical traits. Examples of this are preserving the structural integrity of a plane wing while minimizing its mass or obtaining a flat frequency response of a speakerphone over a broad range of frequencies. Topology optimization is founded on finite element analysis of physical systems, which can be an expensive step for the optimization process – both in computational memory and time. When the size of the finite element system grows, then so does the computational complexity, which can make optimizations infeasible to compute. Model order reduction techniques are therefore sought after to reduce these factors, making large scale optimization possible. When working with second-order equations such as the Helmholtz and mechanical vibration equations, a useful framework is the second-order Krylov subspace methods [1], as they have proven to obtain exact solutions for small number of full matrix factorizations, yielding a significant acceleration in computational time. However, for systems that do not fit into a second-order framework, these methods are not applicable. This is the case with higher order radiation conditions, such as the second-order absorbing boundary condition or perfectly matched layers. With the use of the adaptive Antoulas-Anderson method as a flexible coefficient approximation technique [2], we propose how one can formulate higher order radiation conditions to fit the second order Krylov subspace methods. We demonstrate how this makes it possible to optimize large scale systems within a reasonable timeframe. We test this approach on a speakerphone with fully coupled vibro-acoustic equations for a broad range of frequencies with the goal of achieving a flat frequency response.

References

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