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State space topology optimization method for non-selfadjoint problems in fluid mechanics

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Abstract

Topology optimization literature is traditionally dominated by the optimization algorithms formulated in terms of the design variables only (nested approach). Within this approach the partial differential equations, which govern the state of the system, need to be solved for every function evaluation. Furthermore, the large number of design variables characteristic for topology optimization problems combined with the fact that the Hessian matrix is typically fully populated makes the first order optimization algorithms the most viable alternative and the most popular choice for these formulations.

Recently an alternative approach based on reducing the optimization problem to the state space has resulted in a very efficient algorithm for power-minimization (self-adjoint) problems in topology optimization of incompressible viscous fluid flows. Working in the state space allows one to preserve the sparsity of the utilized PDE discretizations and provides one with a relatively inexpensive access to second and higher order derivatives. Local quadratic and even cubic convergence has been demonstrated by the algorithm [1].

We now apply the state space algorithm to non-selfadjoint problems in fluid mechanics, and evaluate its efficiency for such problems.

[1] A. Evgrafov, On Chebyshev's method for topology optimization problems of Stokes flows, Structural and Multidisciplinary Optimization, Online First (DOI: 10.1007/s00158-014-1176-x), 2015.