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An Augmented Lagrangian preconditioner for the control of the Navier–Stokes equations

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Optimal control problems with PDEs as constraints arise very often in scientific and industrial applications. Due to the difficulties arising in their numerical solution, researchers have put a great effort into devising robust solvers for this class of problems. An example of a highly challenging problem attracting significant attention is the distributed control of incompressible viscous fluid flow problems. In this case, the physics is described by the incompressible Navier–Stokes equations. Since the PDEs given in the constraints are non-linear, in order to obtain a solution of Navier–Stokes control problems one has to iteratively solve linearizations of the problems until a prescribed tolerance on the non-linear residual is achieved.

In this talk, we present efficient and robust preconditioned iterative methods for the solution of the stationary incompressible Navier–Stokes control problem, when employing a Gauss–Newton linearization of the first-order optimality conditions. The iterative solver is based on an augmented Lagrangian preconditioner. By employing saddle-point theory, we derive suitable approximations of the $(1, 1)$-block and the Schur complement. Numerical experiments show the effectiveness and robustness of our approach, for a range of problem parameters.

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