Parameter-Robust Preconditioning for Oseen Iteration Applied to Navier–Stokes Control Problems

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In this talk I will present novel, fast, and parameter-robust preconditioned iterative methods for distributed time-dependent Navier–Stokes control problems with Crank–Nicolson discretization in time. The key ingredients of the solver are a saddle-point type approximation for the linear systems, an inner iteration for the $(1,1)$-block accelerated by a generalization of the preconditioner for convection–diffusion control derived in [2], and an approximation to the Schur complement based on a potent commutator argument applied to an appropriate block matrix. The flexibility of the commutator argument, which is a generalization of the technique derived in [1], allows one to alternatively apply a backward Euler scheme in time, as well as to solve the stationary Navier–Stokes control problem. A range of numerical experiments validate the effectiveness of our new approach.

Joint work with J. W. Pearson*, based on the paper [3].*

References

[1] D. Kay, D. Loghin and A.J. Wathen, *A Preconditioner for the Steady-State Navier–Stokes Equations*, SIAM Journal on Scientific Computing, 24 (2002), pp. 237–256.

[2] S. Leveque and J.W. Pearson, *Fast Iterative Solver for the Optimal Control of Time-Dependent PDEs with Crank–Nicolson Discretization in Time*, to appear in Numerical Linear Algebra with Applications, arXiv preprint arXiv:2007.08410.

[3] S. Leveque and J.W. Pearson, *Parameter-Robust Preconditioning for Oseen Iteration Applied to Stationary and Instationary Navier–Stokes Control*, submitted, arXiv preprint arXiv:2108.00282.