Technische Universität Braunschweig

MUSEN

Parallel-In-Time Integration with Applications to Industrial Problems

Lecture of
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Time-domain simulation of large-scale problems becomes computationally prohibitive if parallelization saturates. This is particularly challenging if long time periods are considered, e.g., if the start-up of an electrical machine until steady state is simulated. In this contribution, several parallel-in-time methods are discussed for initial-boundary-value problems and for time-periodic boundary value problems. All those methods are based on a subdivision of the time interval into as many subintervals as computing cores are available. For example, the well-known parareal [1] method works similarly to multiple shooting methods; it solves two types of problems iteratively until convergence is reached: a cheap problem defined on coarse grids is solved sequentially on the whole time-interval to propagate initial conditions (and approximate derivatives) and secondly, high-fidelity problems are solved on the subintervals in parallel. The parallel-in-time algorithms, their convergence and applicability are discussed, e.g., by demonstrating the results of the simulation of an electrical machine model within an industrial workflow [2].

[1] J.-L. Lions, Y. Maday, and G. Turinici. A parareal in time discretization of PDEs. C. R. Acad. Sci. – Series I – Mathematics, 332(7):661–668, 2001.
[2] D. Bast, I. Kulchytska-Ruchka, S. Schöps, and O. Rain. Accelerated steady-state torque computation for induction machines using parallel-in-time algorithms. IEEE Trans. Magn., 56(2):1–9, 2020. arXiv: 1902.08277.