Simulation of a two-dimensional induction machine with Multigrid-reduction-in-time (MGRIT)

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Due to modern developments in traffic, global warming, and the energy transition, efficient and robust designs of electrical machines are again becoming increasingly important. A major time factor in the design process is the simulation of the behavior of the electrical machine, which is in general based on the so-called magnetoquasistatic approximation or eddy current problem [1]. The discretization of the eddy current problem yields an initial value problem (IVP) for a system of differential-algebraic equations (DAEs), that can be solved by computing one time step after the other. For long time simulations, computational costs are high.

Parallel-in-time methods make use of modern parallel computers and allow us to reduce the time-to-solution for time-dependent evolutionary problems, such as the eddy current problem. The Multigrid-reduction-in-time (MGRIT) [2] algorithm, one parallel-in-time method, uses a time-grid hierarchy for calculating multiple time steps simultaneously. One key advantage of MGRIT compared to other parallel-in-time approaches is its non-intrusiveness, i.e., MGRIT allows reusing existing time propagators and their integration into a parallel framework.

In this talk, we apply the MGRIT algorithm to the eddy current problem of a two-dimensional induction machine and compare the runtime of the time-parallel MGRIT algorithm with the runtime of the sequential forward solve. Furthermore, we add spatial coarsening to the temporal-coarsening strategy of the MGRIT algorithm and investigate the behavior for different relaxation and coarsening strategies. Results demonstrate a significant speedup in comparison with sequential timestepping. Moreover, the use of spatial-coarsening allows efficient simulation of more accurate models.

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References

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