Towards space-time iterative solvers based on balancing domain decomposition

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ABSTRACT

The usual approach to transient problems is to exploit sequentiality in time, and solve one space problem every time step. This approach has recently been re-considered, motivated by the forthcoming exascale supercomputers with billions of cores. This sequential approach has a clear problem, parallelization cannot be exploited in time. Many key computational engineering problems, e.g., in additive manufacturing simulations or turbulent flow simulations, involve even millions of time steps, and a scalable parallel solver in space leads to unacceptable computation times in these problems. On the other hand, space parallelization always saturates at some point (it has no sense, e.g., to consider more processors than finite elements in the mesh) and to efficiently exploit the forthcoming exascale platforms one needs to exhibit further concurrency. In this situation, the development of space-time solvers is an excellent approach because it deals with all time steps at once and exhibits much more concurrency than space-only solvers. In this presentation, we will introduce a new type of (non)linear space-time solvers for the solution of finite element systems arising from the discretization of transient problems, based on the novel extension of balancing domain decomposition methods to space-time [1], and show numerically the scalability of the proposed schemes on a set of academical problems, based on a highly scalable implementation based on overlapped multilevel task implementation [2,3].

References

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[3] S. Badia, A. F. Martín, and J. Principe. A highly scalable parallel implementation of balancing domain decomposition by constraints. SIAM Journal on Scientific Computing, 36(2):C190–C218, 2014.