Asynchronous Time Integrators for Transient Problems in Heterogeneous Media

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Abstract

Evolution of time dependent physical quantities such as current, heat etc., in heterogeneous materials are modeled by initial boundary value problems for parabolic PDEs. These physical quantities follow different evolution patterns in different parts of the computational domain depending on the material properties, size of constituent material subdomains, coupling scheme, etc. Therefore, the stability and accuracy requirements of a numerical integration scheme may necessitate domain dependent time discretization. Parabolic problems are usually solved by discretizing spatially using finite elements and then integrating over time using discrete solvers. We propose an asynchronous multi-domain time integration scheme for parabolic problems. For efficient parallel computing of large problems, we present the dual decomposition method with local Lagrange multipliers to ensure the continuity of the primary unknowns at the interface between subdomains. The proposed method enables us to use domain dependent Rothe method on different parts of a computational domain and thus provide an efficient and robust approach to solving large scale problems.

References

1. M. Benes and A. Nekvinda and M.K. Yadav. Multi-time-step domain decomposition method with non-matching grids for parabolic problems. Applied Mathematics and Computation, Volume 267, 2015, 571-582.