Parallelization of a Multi-level Hp-adaptive Finite Cell Method

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Abstract

The finite cell method (FCM) introduced in [1] combines high-order finite elements with a fictitious domain approach for the solution of partial differential equations. This discretization technique yields a domain that can be easily meshed using structured grids, circumventing the tedious process of mesh generation for complex geometries. The geometry itself is resolved at integration level by means of inside-outside testing. FCM achieves exponential convergence in the strain energy for smooth problems and algebraic convergence for non-smooth problems. Furthermore, FCM has been combined with a novel multi-level *hp*-adaptive scheme presented in [2], resulting in improved convergence behaviour for non-smooth problems. Hierachical, high order meshes are employed to fully utilized the benefit of *hp*-adaptive schemes.

In this contribution, we will present a parallelization concept for a multi-level *hp*-adaptive finite cell method that takes advantage of both the structured computational domain of the finite cell method and the hierachical structure of the multi-level *hp*-adaptive scheme. Based on an object-oriented shared memory code `AdhoC++`, our parallel implementation extends this code in a simple but effective manner, allowing for distributed memory and hybrid computations while effectively using the existing code structure. Moreover, the parallel implementation interfaces the general purpose parallel framework Trilinos, making use of its functionalities for domain decomposition, load balancing and distributed solving. We will present the perfomance of our parellization technique for selected model problems in *hp*-adaptivity as well as its application in real-world engineering problems: computation of bone-implant systems and the simulation of the additive manufacturing process.

References

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