LARGE-SCALE SIMULATIONS WITH UNFITTED FINITE ELEMENT TECHNIQUES

Santiago Badia[1,2], Francesc Verdugo[2], and Alberto F. Martin[1,2]

[1] Department of Civil and Environmental Engineering
Campus Nord UPC, 08034, Barcelona, Spain
e-mail: sbadia@cimne.upc.edu
[2] Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE)
Esteve Terradas 5, Building C3, 08860 Castelldefels, Spain
e-mail: amartin@cimne.upc.edu, fverdugo@cimne.upc.edu

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The use of unfitted finite element methods (FEMs) is an appealing approach for different reasons. They are interesting in coupled problems or to avoid the generation of body-fitted meshes. One of the bottlenecks of the simulation pipeline is the body-fitted mesh generation step and the unstructured mesh partition. The use of unfitted methods on background octree Cartesian meshes avoids the need to define body-fitted meshes, and can exploit efficient and scalable space-filling curve algorithms. In turn, such schemes complicate the numerical integration, imposition of Dirichlet boundary conditions, and the linear solver phase. The condition number of the resulting linear system does depend on the characteristic size of the cut elements, the so-called small cut cell problem.

In this work, we will present an parallel unfitted framework that relies on adaptive octree background meshes and space-filling curve partitioners. In order to solve the small cut cell problem, we propsoe a re-definition of the finite element spaces that solves this issue, leading to condition number bounds as the ones for body-fitted schemes without any kind of perturbation/stabilization of the Galerkin formulation [1,2]. An alternative to this approach is to define appropriate iterative linear solvers based on domain decomposition preconditioning that are robust with respect to the small cut cell problem [3].

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