Concurrent Multiscale Coupling in Solid Mechanics via the Schwarz Alternating Method

Abstract. This talk presents some recent developments in advancing the Schwarz alternating method as a means for concurrent multiscale coupling in finite deformation solid mechanics. First, we describe the algorithm's variational formulation and convergence properties: the method's convegence rate is geometric provided each of the subdomain problems is well-posed and the overlap size is non-zero. Next, we show that the use of a Newton-type method for the solution of the resultant nonlinear system leads to two kinds of block linearized systems, depending on the treatment of the Dirichlet boundary conditions. The first kind is a symmetric block-diagonal linear system in which each diagonal block is the tangent stiffness of each subdomain, so that the coupling is only through the right-hand side. The second kind is a nonsymmetric block system with off-diagonal coupling terms. We present several variants of the Schwarz alternating method that we have developed for the first kind of linear system, including one in which the Schwarz and Newton iterations are combined into a single scheme. An upshot of this version of the method is that it lends itself to a minimally intrusive implementation into existing finite element codes. We describe our implementation of the Schwarz alternating method in Albany, an open-source multiphysics research platform. Finally, we demonstrate the accuracy, convergence and scalability of the proposed Schwarz variants on several solid mechanics examples.

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