Nonlinear Multigrid solver exploiting AMGe Coarse Spaces with Approximation Properties

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Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

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NONLINEAR MULTIGRID SOLVER EXPLOITING AMGe COARSE SPACES WITH APPROXIMATION PROPERTIES

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The paper introduces a nonlinear multigrid solver for mixed finite element discretizations based on the Full Approximation Scheme (FAS) and element-based Algebraic Multigrid (AMGe). The main motivation to use FAS for unstructured problems is the guaranteed approximation property of the AMGe coarse spaces that were developed recently at Lawrence Livermore National Laboratory. These give the ability to derive stable and accurate coarse nonlinear discretization problems. The previous attempts (including ones with the original AMGe method), were less successful due to lack of such good approximation properties of the coarse spaces. With coarse spaces with approximation properties, our FAS approach on unstructured meshes has the ability to be as powerful/successful as FAS on geometrically refined meshes. For comparison, Newton's method and Picard iterations with an inner state-of-the-art linear solver are compared to FAS on a nonlinear saddle point problem with applications to porous media flow. It is demonstrated that FAS is faster than Newton's method and Picard iterations for the experiments considered here. Due to the guaranteed approximation properties of our AMGe, the coarse spaces are very accurate, providing a solver with the potential for mesh-independent convergence on general unstructured meshes.

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