Accepted Manuscript

A multiscale flux basis for mortar mixed discretizations of Stokes-Darcy flows

Benjamin Ganis, Danail Vassilev, ChangQing Wang, Ivan Yotov

PII: S0045-7825(16)30874-X
DOI: http://dx.doi.org/10.1016/j.cma.2016.09.037
Reference: CMA 11149

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date: 4 August 2016
Accepted date: 28 September 2016

Please cite this article as: B. Ganis, D. Vassilev, C. Wang, I. Yotov, A multiscale flux basis for mortar mixed discretizations of Stokes-Darcy flows, *Comput. Methods Appl. Mech. Engrg.* (2016), http://dx.doi.org/10.1016/j.cma.2016.09.037

A multiscale flux basis for mortar mixed discretizations of Stokes-Darcy flows

Benjamin Ganis[§] Danail Vassilev[‡] ChangQing Wang[*] Ivan Yotov[*]

August 1, 2016

Abstract

A multiscale flux basis algorithm is developed for the Stokes-Darcy flow problem. The method is based on a non-overlapping domain decomposition algorithm, where the global problem is reduced to a coarse scale mortar interface problem that is solved by an iterative solver. Subdomain solves are required at each interface iteration, so the cost for the method without a multiscale basis can be high when the number of subdomains or the condition number of the interface problem is large. The proposed algorithm involves precomputing a multiscale flux basis, which consists of the flux (or velocity trace) response from each mortar degree of freedom. It is computed by each subdomain independently before the interface iteration begins. The subdomain solves required at each iteration are substituted by a linear combination of the multiscale basis. This may lead to a significant reduction in computational cost since the number of subdomain solves is fixed, depending only on the number of mortar degrees of freedom associated with a subdomain. Several numerical examples are carried out to demonstrate the efficiency of the multiscale flux basis implementation for large-scale Stokes-Darcy problems.

Keywords. Multiscale flux basis, mortar finite element, mixed finite element, Stokes-Darcy flow, non-overlapping domain decomposition, FETI method, balancing preconditioner

[1]Center for Subsurface Modeling, The Institute for Computational Engineering and Sciences, The University of Texas at Austin, TX, 78712, USA; bganis@ices.utexas.edu

[2]Cobham plc, UK

[3]Department of Mathematics, University of Pittsburgh, Pittsburgh, PA 15260, USA; chw92@pitt.edu,yotov@math.pitt.edu; partially supported by NSF grant DMS 1418947 and DOE grant DE-FG02-04ER25618.