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Original Article

Adaptive BDDC in three dimensions

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Abstract

The adaptive BDDC method is extended to the selection of face constraints in three dimensions. A new implementation of the BDDC method is presented based on a global formulation without an explicit coarse problem, with massive parallelism provided by a multifrontal solver. Constraints are implemented by a projection and sparsity of the projected operator is preserved by a generalized change of variables. The effectiveness of the method is illustrated on several engineering problems.

Keywords: Parallel algorithms; Domain decomposition; Iterative substructuring; BDDC; Adaptive constraints

1. Introduction

The *Balancing Domain Decomposition by Constraints* (BDDC) was developed by Dohrmann [6] as a primal alternative to the *Finite Element Tearing and Interconnecting – Dual, Primal* (FETI-DP) by Farhat et al. [7]. Both methods use constraints to impose equality of new “coarse” variables on substructure interfaces, such as values at substructure corners or weighted averages over edges and faces. Primal variants of the FETI-DP were also independently proposed by Cros [4] and by Fragakis and Papadrakakis [10]. It has been shown in [27,37] that these methods are in fact the same as BDDC. Polylogarithmic condition number bounds for FETI-DP were first proved in [29] and generalized to the case of coefficient jumps between substructures in [14]. The same bounds were obtained for BDDC in [23,24]. A proof that the eigenvalues of the preconditioned operators of both methods are actually the same except for the eigenvalues equal to one was given in [24] and then simplified in [2,20,27]. FETI-DP, and, equivalently, BDDC are quite robust. It can be proved that the condition number remains bounded even for large classes of subdomains with rough interfaces in 2D [12,39] as well as in many cases of strong discontinuities of coefficients, including some configurations when the discontinuities cross substructure boundaries [31,32]. However, the condition number deteriorates in many situations of practical importance and a better selection of constraints is desirable. Enriching the coarse space so that the iterations run in a subspace devoid of “difficult” modes has been a successful trick in

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