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Original article

Face-based selection of corners in 3D substructuring

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Abstract

In most recent substructuring methods, a fundamental role is played by the coarse space. For some of these methods (e.g. BDDC and FETI-DP), its definition relies on a 'minimal' set of coarse nodes (sometimes called corners) which assures invertibility of local subdomain problems and also of the global coarse problem. This basic set is typically enhanced by enforcing continuity of functions at some generalized degrees of freedom, such as average values on edges or faces of subdomains. We revisit existing algorithms for selection of corners. The main contribution of this paper consists of proposing a new heuristic algorithm for this purpose. Considering faces as the basic building blocks of the interface, inherent parallelism, and better robustness with respect to disconnected subdomains are among features of the new technique. The advantages of the presented algorithm in comparison to some earlier approaches are demonstrated on three engineering problems of structural analysis solved by the BDDC method.

Keywords: Domain decomposition; Iterative substructuring; BDDC; Parallel algorithms; Corner selection

1. Introduction

The Balancing Domain Decomposition based on Constraints (BDDC) is a numerically scalable, nonoverlapping (substructuring), primary domain decomposition method introduced in 2003 by Dohrmann [4]. Its algebraic theory developed by Mandel et al. [14] demonstrates close relation to FETI-DP introduced by Farhat et al. [5]: the eigenvalues of the preconditioned problem in BDDC and FETI-DP are the same except possibly those equal to 0 and 1 (see also [2,13,18] for simplified proofs). These results not only provide the theoretical reasoning for nearly identical performance of BDDC and FETI-DP observed earlier, but also imply, that many theoretical results obtained for one method apply readily to the other.

The *coarse space*, defined by constraints on continuity of functions across the interface at *coarse degrees of freedom*, is essential for the performance of both methods. A historical overview of an evolution of the concept of the coarse space is presented, e.g., by Widlund [23] and by Mandel and Sousedík [17]. The usual basic choice of coarse degrees of freedom is presented by selecting a set of *coarse nodes* (also called *corners*). This set is usually selected to be 'minimal' in the sense that it is as small as possible while assuring invertibility of local subdomain problems and of

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