

Generation of Subdomains and Subdomain Clusters for Domain Decomposition Methods

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Abstract: The practical use of dual-type and balancing Domain Decomposition Methods (DDMs) on parallel computing environments with independent numbers of subdomains and processors constitutes today a basic feature of these solution approaches. The dominant objective during the mesh partitioning task is to produce subdomains with specific geometric characteristics, in order to improve the conditioning of the interface problem. The number of generated subdomains is in general larger than the number of available processors, since the computational performance of dual-type and balancing DDMs is improved both in terms of overall execution time and storage requirements by using mesh partitions with increased numbers of subdomains. Thus, an additional computational task has to be performed, in order to produce subsets of the global problem for the available processors by appropriately organizing the subdomains, generated during the mesh partitioning task, into subdomain clusters.

The performance of dual-type and balancing DDMs is affected by the quality of the produced subdomain clusters. The aim of the additional task for the generation of the clusters is to yield balanced subsets of the domain decomposition problem with minimum communication requirements during the iterative solution procedure. The simple techniques used up to now for this purpose do not always address the issue of communication minimization effectively. This deficiency is overcome with the heuristic approach presented in this work, according to which the task of subdomain cluster generation is handled as a graph partitioning optimization problem: the mesh partitioning output is translated into weighted graph data (vertices represent subdomains and edges are associated with subdomain connectivity), which are used as input to standard graph partitioning software, in order to organize the subdomains into balanced subdomain clusters with minimum edgecut. Performance results of the presented algorithm for subdomain cluster generation are obtained with a network-distributed FETI implementation executed on ethernet-networked PCs using the Linux operating system and the message passing software PVM.

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