Optimal element numbering schemes for direct resolution of mechanical problems using domain decomposition method.

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The aim of the current work is the resolution of linear systems by a domain decomposition direct method. We are interested particularly in linear systems obtained in finite element method. We solve first the initial problem independently in each subdomain, and then we add constraints to fit the local solutions on the boundaries between the subdomains. The Schur Complement method ensures the equality of forces at the interfaces between subdomains.

The decomposition policy is quantified by a load balancing metrics: usually we aim at an equal number of equations over each subdomain while minimizing the size of the interface problem. This decomposition is based on the assumption that the resolution time is varying linearly with the number of equations (nodes) of each subdomain. The first improvement is obtained by using a more realistic estimation of the number of operations involved in the elimination of internal degrees of freedom. The resolution time of each subdomain is further reduced by the local element ordering scheme.

The objective being the minimization of the global resolution time, we have to solve simultaneously three problems: partitioning of the mesh, minimizing the local resolution time and ensure a global load balance. In the current work, we iteratively improve the initial partitioning of the mesh by transferring selected finite elements from the "expensive" subdomains to the "cheap" ones. The criterion is the estimation time on the locally renumbered meshes.

The treated issues in the paper concern the performance of different renumbering strategies. We first introduce a new objective function which gives a precise estimation of the computing time of the variant of the frontal method used in the computations. This function enables us to accurately compare different heuristics. Next, we propose two improvements to some classical heuristics, two greedy algorithms and a Tabu Search method.

Performance results are obtained on a cluster of linux based pc-s using the pvm message passing library. The benchmark examples are those of the Everstine collection and a series of meshes corresponding to realistic industrial problems of varying complexity. These results are discussed referring to the performance of the same program running on a SGI ORIGIN 2000 and CRAY T3E supercomputers and using alternatively dedicated pvm and SHMEM libraries.