A Distributed-Memory Hierarchical Solver for Sparse Matrices

Eric Darve [1]

C. Chen, H. Pouransari, L. Cambier [2]

S. Rajamanickam, E. Boman, R. Tuminaro [3]

We present a parallel hierarchical linear solver for solving large, sparse linear systems on distributed-memory machines. The fully algebraic algorithm exploits the low-rank structure of fill-in blocks during the Gaussian elimination process, and it is thus faster and more memory-efficient compared with sparse direct solvers. Our hierarchical solver can be used as a direct solver (high-accuracy setting) or a preconditioner (low-accuracy setting). The parallel implementation is based on a data decomposition such that only local communication is needed for updating boundary information on every processor. Our algorithm is based on dense linear algebra subroutines, which can potentially be accelerated using modern many-core processors. We show various numerical experiments to demonstrate the scalability of our solver and compare it with a state-of-the-art sparse direct solver. The new hierarchical solver achieves an average speedup of 45 in factorizing three two-million sized test problems on 256 cores of a supercomputer.

[1] Stanford University, USA (eric.darve@stanford.edu)
[2] Stanford University, USA
[3] Sandia National Labs, USA