A Scalable Parallel Preconditioned Sparse Linear System Solver

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Achieving high parallel scalability of sparse linear system solvers implemented on large-scale computing platforms comprised of tens of thousands of multicore processors is a task that offers many challenges. Towards achieving such a solver, we extract an effective banded (sparse within the band) preconditioner for use with an outer Krylov subspace method. The extraction of such banded preconditioners is made possible via a fast parallel reordering scheme based on the computation of the Fiedler vector of the weighted Laplacian of the corresponding sparse matrix under consideration. Solving systems involving these banded preconditioners (narrow-banded, generalized-banded, or wide-banded) is accomplished via members of the SPIKE family of solvers. The resulting hybrid parallel sparse system solver, P-SPIKE (for Pardiso-Spike), is made quite scalable via a specialized version of the sparse direct solver Pardiso. We show that our solver is quite competitive in performance and robustness compared to current parallel direct solvers, as well as Krylov subspace methods preconditioned via: (i) approximate LU-factorization, and (ii) algebraic multigrid schemes.

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