Parallel direct solvers for the Helmholtz equation

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Abstract

A short survey is given of parallel sparse direct solvers possibly suitable for solving wave equation problems. Given the specific features of a problem typical of a seismic survey, two state-of-the-art software packages have been singled out for efficiency testing on problems derived from finite difference discretizations of the Helmholtz equation. These packages are MUMPS and SuperLU_DIST and the tests have been carried out on Linux clusters. Results from time and memory scalability tests for sets of very large sparse matrices are presented. It is concluded that the MUMPS algorithm performs better than SuperLU_DIST on Linux cluster platforms for structurally symmetric, but extremely sparse problems. However, the efficiency of the solution phase is far from satisfactory on this type of architecture. This circumstance becomes especially critical for applications where the equation systems need to be solved for multiple right hand sides, which is the case when modeling a seismic survey. Several improvements of the MUMPS solve phase algorithm are suggested in order to avoid costly communication. The results of these improvements are demonstrated for a typical geophysical problem. The performance of MUMPS as a direct parallel solver for this type of application is also compared with the case where MUMPS is used as the core algorithm in a direct substructuring approach.