Performing acoustic, vibro-acoustic and aero-acoustic computations using MUMPS

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Abstract

This talk focuses on the direct solution of large complex indefinite unsymmetric systems, that arise in acoustic, vibro-acoustic and aero-acoustic simulations. These systems are structurally symmetric and may contain some large dense blocks, e.g. due to the selection of hybrid modal/physical representations in the model.

The first part of the talk gives an overview of the experienced MUMPS capabilities and difficulties for solving systems with up to a few million degrees of freedom. The focus will be on parallel computations, both by using the distributed MUMPS version, and by running several (sequential) MUMPS instances simultaneously on a compute node. We will illustrate how the memory consumption of the distributed MUMPS solver is affected by increasing the number of processors and by changing the type of ordering scheme. In the case of running multiple sequential MUMPS instances in parallel that share a same scratch disk, I/O congestion during out-of-core backtransformation may lead to excessive computation times, which we avoid by imposing a time delay between the several MUMPS instances that enter the backtransformation phase simultaneously.

During the second part of the talk, the performance of the sequential MUMPS solver is compared to other sparse direct solvers, in particular to PARDISO MKL and UMFPACK. A benchmark study was performed on a selection of representative test cases, both from automotive and aerospace industry. We observed that out-of-core MUMPS may lead to the lowest memory requirements on the vibro- and aero-acoustic test cases. These problems are typically less sparse than pure acoustic ones. In terms of computational efficiency, MUMPS with multithreaded BLAS generally outperformed the other solvers in the case of a limited number of threads.