Improving (aero/vibro-)acoustic simulations using MUMPS: evaluation of Block Low-Rank factorizations

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Abstract

This talk focuses on a wide range of acoustic, vibro-acoustic and aero-acoustic applications which are handled by Actran, a finite element software package developed by Free Field Technologies. MUMPS has been used in Actran for more than 10 years for solving large, sparse linear systems resulting from finite element simulations. These systems are mostly complex, unsymmetrical with a symmetric structure and hold up to a few million degrees of freedom. In the first part of the talk, we will review the usage of MUMPS inside Actran. For example, we will demonstrate on a large 3D aero-acoustic application, which requires a 64-bit integer representation, how a better performance was achieved with out-of-core MUMPS using the newly selective 64-bit integer option and a sparse right-hand side representation compared to out-of-core 64-bit Intel MKL Pardiso.

In order to decrease the factorization time, the recently added Block Low-Rank factorization in MUMPS is evaluated and compared to the full factorization. The second part of this talk demonstrates the effectiveness of the Block Low-Rank factorization on several types of applications. Appropriate dropping parameters are determined in order to maintain a sufficient level of accuracy while enabling a low-rank compression during the factorization. We will show how significant performance improvements were obtained on acoustic radiation problems compared to using a full factorization, while smaller improvements were seen on for example vibro-acoustic applications. The parallel efficiency of the full and Block Low-Rank factorization will be compared in terms of multithreaded (SMP) and multiprocessor (DMP) parallel computing.