

MUMPS and the finite element library Getfem++ as a flexible environment for PDE numerical simulation

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Abstract

In many applications, the solution of PDE problems after discretization requires to solve sparse linear systems efficiently. The memory needs depend on the dimension of the problem that may lead us to consider sequential or parallel solvers. The presentation is devoted to a flexible environment to manage : the discretization, the resolution and the visualization of the solution.

For the discretization part, we consider the finite element environment GETFEM++ [<http://home.gna.org/getfem/>], which is a C++ library of generic finite element functionalities, that enables to express in a simple way the finite element discretization of PDE problems, including various types of 2D or 3D finite elements, and that can be used for many PDE applications including structural analysis and mesh deformation. Additionally, GETFEM++ allows for parallel distributed data manipulation and assembly, and this is one of the key features to address appropriately the type of problems that we are interested in.

For the solution of the large sparse linear systems arising from the finite element assembly, we also use the multifrontal massively parallel solver package MUMPS [<http://mumps.enseeiht.fr/>], which implements a parallel distributed LU factorization of large sparse matrices. Since MUMPS enables to specify, as input, an already distributed sparse linear system, it was easy for us to integrate the MUMPS package into GETFEM++ in order to design a complete and generic parallel distributed chain from the finite element discretization to the solution of the PDE problems

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We shall describe the key points in the data exchange between GETFEM++ and MUMPS to design this generic and flexible platform, and we present the preliminary sequential and parallel experiments using this new combination of GETFEM++ and MUMPS. We also discuss possible improvements, and in particular the interest for new features such as sparse distributed right hand side and solution vectors in Mumps, which may help to reduce data communication. Besides that, we also discuss possible improvements in the memory allocation in Getfem++, using a similar approach as for the sparse distributed vectors in Mumps.
