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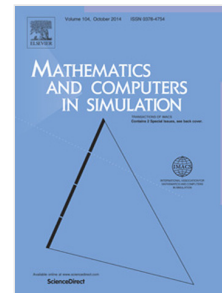
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A parallel library for boundary element discretization of engineering problems

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Abstract

In this paper we present a software for parallel solution of engineering problems based on the boundary element method. The library is written in C++ and utilizes OpenMP and MPI for parallelization in both shared and distributed memory. We give an overview of the structure of the library and present numerical results related to 3D sound-hard scattering in an unbounded domain represented by the boundary value problem for the Helmholtz equation. Scalability results for the assembly of system matrices sparsified by the adaptive cross approximation are also presented.

Keywords: boundary element method, sound scattering, Helmholtz equation
2010 MSC: 65N38, 68N01

1. Introduction

The boundary element method (BEM) is a counterpart to the finite element method often used for the solution of engineering problems. The basic idea of BEM is to reduce the problem to the boundary of the computational domain. Thus, there is no need for volume meshing and the method is well suited for problems in unbounded domains (e.g., sound scattering problems) or shape optimization problems. On the other hand, the classical BEM approach results in dense system matrices, which leads to quadratic time and memory complexity with respect to the number of degrees of freedom on the boundary. Due to singular kernels of the boundary integral operators one also has to pay a special attention when assembling the matrices. We mention several ways of dealing with these issues. A detailed mathematical background of BEM is beyond the scope of this text; an interested reader should consult, e.g., [9, 10, 13].

The main part of the paper is devoted to BEM4I, a new library of parallel solvers based on BEM. The software is written in C++ and uses OpenMP and MPI for parallelization in shared and distributed memory, respectively.

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