Study on Parallelization of the Adaptive Finite Element Package ALBERT

QingKai Liu

Abstract

This dissertation presents our work on parallization of the adaptive finite element package ALBERT (Adaptive multi-Level finite element toolbox using Bisection refinement and Error control by Residual Techniques).

The first part of the dissertation presents a new parallel adaptive local mesh refinement algorithm using bisection, which is suitable for parallel computer, especially distributed memory parallel computers. First, an improved implementation of Kossaczky's bisection mesh refinement algorithm is described. By dividing the recursive bisection procedure into two separate steps, namely marking and refinement, the new algorithm avoids possible infinite recursions due to inappropriate selection of refinement edges in the initial mesh. Then the parallel bisection mesh refinement algorithm is given. It is shown both theoretically and through numerical experiments that the parallel algorithm produces the same results as the serial one, and can be efficiently implemented on distributed memory computers.

The second part of the dissertation deals with the parallelization of ALBERT. The parallel code is based on our parallel bisection mesh refinement algorithm and on several other well known packages including METIS/ParMETIS for mesh partitioning and PETSc for solution of linear systems. Existing data structures and algorithms in ALBERT have been modified and new data structures and algorithms have been designed in order to efficiently implement the parallel code. The present code provides all main functionalities required by a parallel adaptive finite elementsolver for time independent 2D problems: mesh partitioning, parallel assemblage and solution of linear systems, parallel evaluation of error indicators, parallel mesh refinement, and load balance based on mesh redistribution. Numerical experiments showed that our parallel code is robust and has good efficiency and scalability.

Keywords: finite element method, adaptive method, bisection mesh refinement, parallel algorithm, MPI