Annual Report 2001 of the project P14953

Robust Algebraic Multigrid Methods and their Parallelization

The aim of the project, that started on October 2001, consists in the construction of robust, flexible and efficient Algebraic MultiGrid (AMG) methods and their applications to real life problems. Due to our proposal the general approach of AMG methods (proposed in the PhD theses of S. Reitzinger) has been further developed. We have made four essential extensions:

1. AMG methods for boundary element discretizations,
2. AMG methods for complex symmetric system matrices,
3. AMG methods for Navier-Stokes equations and
4. parallel AMG applications in life science.

The requirement of fast solvers for full (latter for a sparse approximation) boundary element matrices is of growing interest, since industry uses such discretization techniques recently as an important simulation tool.

The second topic is a joint work with the group of Prof. Ursula van Rienen, University of Rostock, Germany. The AMG method was extended to the solution of complex symmetric equations arising from the simulation of high voltage insulators.

The development of an AMG-solver for (incompressible) Navier-Stokes equations, which started during the FFF-project "Automatischer Multi-Element Netzgenerator und Strömungssimulator AUTOGEN" (January 1998 – June 2001) was continued. This solver (called AMUSE) is conceived to use an (almost) arbitrary scalar AMG-strategy and generate thereof everything which is required for the whole (nonsymmetric, indefinite) system of Navier-Stokes equations. Thus it is possible to use 'PEBBLES' as generator of the coarse level systems.

Due to some theoretical progress (local smoothers of Vanka-type, alternative coarsening strategies) we are getting closer to a point, where we are able to simulate real-life-problems of fluid dynamics (i.e. complex geometries like the interior of a car, the flow outside a car or real 3D problems, or flows with strong convection, i.e. large Reynolds number) in reasonable time.

The final item is devoted to a joint work with C. Wolters, Max-Plack-Institute Leipzig, Germany. We integrated the parallel AMG software package PEBBLES in the package NeuroFEM-Pebbles which has the task of an inverse source reconstruction tool. The problem class comes out from life science, e.g. to detect defective areas in the human brain.

All results including the publications can be found on our project home-page

`http://www.numa.uni-linz.ac.at/Research/Projects/P14953.html`