ERCIM "Alain Bensoussan" Fellowship Scientific Report

Fellow: Irina Vaseva
Visited Location : University of Warsaw, PLERCIM
Duration of Visit: 15.10.2008 – 14.10.2008

I - Scientific activity

During my ERCIM "Alain Bensoussan" Fellowship at the University of Warsaw my research activity was devoted to the numerical investigation of partial differential equations with discontinuous coefficients. The main purpose of my work was the numerical analysis and implementation of the multilevel additive Schwartz preconditioner for a Discontinuous Galerkin discretization of a Dirichlet problem for second-order elliptic equations with discontinuous coefficients.

The problem is considered on a two-dimensional polygonal region consisted of polygonal subregions. The positive coefficients of the problem are discontinuous across the interfaces. The triangulation is matching in each subregion and can be nonmatching across the interfaces. The problem is approximated using continuous piecewice linear finite elements on each subreagion and discontinuous across the interfaces. The discrete problem is formulated using the symmetric Discontinuous Galerkin method with interior penalty term across the interfaces. In the discrete formulation the coefficients of the problem as well as the mesh sizes are replaced by harmonic averages on the interfaces.

The multilevel additive Schwartz preconditioner is defined on a sequence of nested triangulations obtained from the initial shape regular coarse triangulation using the uniform refinement technique. The initial problem is replaced by the simple problems defined on each level.

The convergence rate of the method depends on the number of levels and on the ratio H/h, where H is the parameter of the coarse mesh and h is the parameter of the fine mesh of the nested triangulation. The convergence rate does not depend on the jumps of the coefficients. In the numerical experiments the computational region is considered as a rectangular and the coefficients of the problem are taken as constants in each subregion. The preconditioned system of linear equations is solved using the conjugate gradient method.

The numerical results confirm the theoretical ones.

II- Publication(s) during your fellowship

I am preparing the technical report which will be published at the Department of Mathematics, Informatics and Mechanics of the University of Warsaw.

III -Attended Seminars, Workshops, and Conferences

I was invited to give a talk in the following seminars:

"Numerical analysis of PDEs", Mini-Symposium "Recent Trends in Applications of Mathematics to Biology and Medicine V", December 12, 2007, Warsaw, Poland

"Application of Inverted Beltrami and Diffusion Equations to Adaptive Mesh Generation" Seminar of the Numerical Analysis Group, University of Warsaw, December 13, 2007, Warsaw, Poland

"On an Approach to Adaptive Mesh Generation" Seminar of the Institute of Computational Science, ETH Zurich, April 16, 2008, Zurich, Switzerland

"On an Approach to Adaptive Mesh Generation" and "On Multilevel ASM for DG Discretization of Elliptic Problems with Discontinuous Coefficients", CWI, September 2, 2008, Amsterdam, the Netherlands

I attended the seminars of the Numerical Analysis Group of the University of Warsaw.

IV – Research Exchange Programme (12 month scheme)

Institute of Computational Science, ETH Zurich (SARIT) with Dr. Peter Arbenz, April 13-27, 2008, Zurich, Switzerland
CWI with Prof. Barry Koren, August 30 – September 7, 2008, Amsterdam, the Netherlands

During both visits I had a possibility to meet with researches working in the fields I am interested. I became acquainted with their work, exchanged ideas with them, discussed the possibilities of a future collaboration.
During my stay in Switzerland I also visited the Paul Scherrer Institute.