Department of Mathematical Sciences Colloquium

Pavel Solin

Multi-Mesh Finite Element Methods for Nonlinear Coupled Problems

Many important processes in engineering and science involve the interaction of multiple physical fields – these are called coupled problems. One of the simplest coupled problems are the Lamé equations of linear elasticity that describe mutual interaction of spatial displacement components in elastic materials. However, most coupled problems are nonlinear and much more difficult to solve. One such example are the Navier-Stokes equations describing the nonlinear interaction of velocity components and pressure in incompressible viscous flows. Other examples include electromagnetic induction heating, electromagnetic fluid mixing, fluid-structure interaction, and many others.

From the mathematical point of view, such coupled problems can be described by systems of partial differential equations (PDEs). The most powerful tool for the computer solution of PDEs is the finite element method (FEM). However, the application of FEM (and other methods) to coupled problems has been rather limited until now. This has multiple reasons, all related to their excessive difficulty. For example, mathematical analysis of existence and uniqueness of solution to most coupled problems is virtually impossible. The numerical analysis is complicated by completely new phenomena which were unknown in standard single-field problems.

In this talk we will discuss some of these issues, and introduce a new concept of FEM for coupled problems where all physical fields are approximated on geometrically different meshes. Until now it was standard to use the same finite element mesh for all fields. We will show that the new approach can make the computations much faster and more reliable. The multi-mesh approach contains a large potential which we intend to exploit in the future. We will mention some other applications and related open problems.

Friday, September 14, 2007 at 3 pm in Bell Hall 143
The University of Texas at El Paso

Refreshments will be served in front of the colloquium room, 15 minutes before the start of the colloquium.

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