Department of Mathematical Sciences

Spring 2016

Colloquium Series

Monday, February 29 , 2016 at 3pm in Bell Hall 143

Note the unusual colloquium day

Candidate for Computational Science faculty position

Dr. Xianyi Zeng

Duke University

A variational multiscale finite element method for transient solid mechanics using linear simplicial elements

Low-order (no more than second-order) finite element methods (FEM) are usually preferred in solid mechanics problems, because they require only a few quadrature points to compute the volume or surface integrals accurately. This is particularly important for inelastic materials, when the computational cost is dominated by evaluating the stress tensor at these quadrature points. When the material property is in the incompressible limit, however, people tend to avoid triangular or tetrahedral elements for the following reason: The standard Galerkin formulation is not well-posed in this scenario, in the sense of violating the inf-sup condition. This drawback strictly limits the usage of low-order FEMs for problems that involve complicate geometries. In this talk, I will present a simple stabilized method to resolve this issue. The method is based on a mixed formulation, in which the usual momentum equation is complemented by a rate equation for the evolution of the pressure. The stabilization is then derived using a variational multiscale (VMS) approach, which leads to provable energy stability, at least in the case of isotropic linear elasticity. The method is then extended to nonlinear hyperelastic materials, as well as inelastic ones such as the elastoplastic and viscoelastic solids. Extensive numerical results are presented to demonstrate the accuracy and stability of the proposed method in these contexts. Finally, I will conclude the talk by a brief review of my previous work in a VMS-stabilized method for shock hydrodynamics, and combining the two methods to solve several fluid-structure interaction problems.

For further information, please contact Drs. Emil Schwab or Xiaogang Su, eschwab@utep.edu or xsu@utep.edu