Department of Mathematics

University of Houston

Scientific Computing Seminar

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Applications of Advanced Numerical Methods on Problems with Complex Physics and Complex Geometry

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10 AM- 11 AM
Room 646 PGH

Abstract:

In this presentation, two high order accurate numerical methods, Spectral Element Method (SEM) and Discontinuous Galerkin method (DG), are discussed. Particular problems in complex geometry with complex physics are investigated and their high order accurate numerical solutions are obtained. Besides, the GPU implementation of Smoothed Particle Hydrodynamics (SPH) method is presented. Numerical simulations of the fluid and structure interactions with a free surface are presented.

In particular, four independent projects that I have completed are sequentially presented. First, to solve the natural convection problem, a high order SEM solution is provided. The algorithm can obtain much detailed resolutions with moderate computational efforts (hp-refinement). Second, to simulate the reaction diffusion process in human neuromuscular junction, a more realistic and complete reaction model is developed, and SEM is used to provide a high order accurate numerical solution for the model. The results successfully predicted the distribution and amount of acetylcholine receptors during a normal action potential, and these results further help us gain a better understanding of the process. Third, to study the fluid problems with moderately high Reynolds (Re) number such as: flow passing a vertical cylinder and lid-driven cavity flow, high order DG method is used. Unstructured meshes (triangular element or tetrahedron) are adopted in the DG solver, which give greater ability than structured meshes in solving problems with very complex geometry. Last, to generate simulations of particular fluid and structure interactions, the GPU-implemented SPH method is used. The simulation results demonstrate the advantage of the SPH solver for solving fluid problems with complex geometry, rapid deformation and even discontinuity (wave-break) without computational grids. Furthermore, a noticeable speedup of our GPU implementation over the serial version on CPU is achieved.

This seminar is easily accessible to persons with disabilities. For more information or for assistance, please contact the Mathematics Department at 743-3500.