Boulder Fluid Dynamics Seminar Series

Tuesday, February 24, 2015
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Visualization and Analysis of Large-Scale Wind Turbine Array Simulations

Kenny Gruchalla, *National Renewable Energy Laboratory*

As the United States moves toward utilizing more of its wind and water resources for electrical power generation, computational modeling will play an increasingly important role in improving the performance, decreasing costs, and accelerating deployment of wind and water power technologies. We are developing computational models to better understand the wake effects of wind and marine hydrokinetic turbines. I will describe how we are developing and using visualization techniques to analyze the large-scale data resulting from these simulations.

Level-set XFEM Topology Optimization of 3D Navier-Stokes and Scalar Transport Problems

Carlos Villanueva, *University of Colorado, Boulder*

This presentation studies level-set XFEM topology optimization of incompressible Stokes and Navier-Stokes flow and scalar transport problems. The study expands on previous work on the LSM-XFEM optimization framework by [1] to three-dimensions. The LSM describes the geometry by defining the nodal level set values via explicit functions of the optimization variables. The flow behavior is predicted by a generalized version of the XFEM.

The focus of the study is to analyze the correct application of boundary conditions at the level set interface to model high Reynolds number flow in optimization problems. To capture the discontinuities caused by the LSM, Heaviside enrichments are applied for both velocity and pressure field. Nitsche's method [2] is then used to weakly impose the continuity of the velocity field. Ghost penalty terms for velocity and pressure are added for stability reasons and to improve the conditioning of the system matrix, independent of the location of the interface. The method has been previously applied to incompressible Navier-Stokes flows by using face-oriented fluid stabilizations for both viscous and convective dominated flows. In this study, the method is expanded to a multiple enrichment XFEM flow formulation with a scalar transport field. Using these approaches, we will generate a robust optimization approach capable of handling multiple discontinuities at the cut elements, and modeling coupled physics such as fluid flow and advection-diffusion problems.

[1] Makhija D, Maute K (2014) Level set topology optimization of scalar transport problems. Structural and Multidisciplinary Optimization DOI 10.1007/s00158-014-1142-7
[2] Burman E, Hansbo P (2012) Fictitious domain finite element methods using cut elements: II. a stabilized nitsche method. Applied Numerical Mathematics 62(4):328–341
[3] Schott B, Rasthofer U, Gravemeier V, Wall W (2014) A face-oriented stabilized nitsche-type extended variational multiscale method for incompressible two-phase flow. International Journal for Numerical Methods in Engineering