ACMS Applied Math Seminar

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Thursday, April 7, 2016

154 Hurley Hall

3:30- 4:30 PM

Efficient Modeling of Incompressible Fluid Dynamics at Moderate Reynolds Numbers by Deconvolution LES Filters

We consider a Leray model with a deconvolution-based indicator function for the simulation of incompressible fluid flow at moderately large Reynolds number (in the range of few thousand) with under-refined meshes. For the implementation of the model, we adopt a three-step algorithm called evolve-filter-relax (EFR) that requires the solution of a Navier-Stokes problem, the solution of a Stokes-like problem to filter the Navier-Stokes velocity field, and a final relaxation step. We take advantage of a reformulation of the EFR algorithm as an operator splitting method to analyze the impact of the filter on the final solution vs a direct simulation of the Navier-Stokes equations. In addition, we provide some direction for tuning the parameters involved in the model based on physical and numerical arguments. Our approach is validated against experimental data for fluid flow in an idealized medical device (consisting of a conical convergent, a narrow throat and a sudden expansion, as recommended by the Food and Drug Administration). Numerical results are in good quantitative agreement with the measured axial components of the velocity and pressures for two different flow rates corresponding to turbulent regimes, even for meshes with a mesh size more than 40 times larger than the smallest turbulent scale. Through a large set of numerical experiments, we perform a preliminary sensitivity analysis of the computed solution to the parameters involved in the model.

The Department of Applied and Computational Mathematics and Statistics

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