Simulation workflow of multiphysics coupling using immersed methods
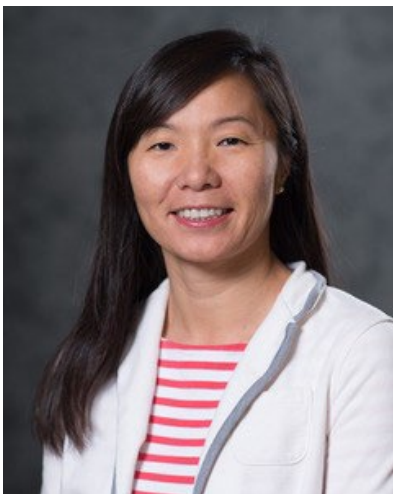
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Abstract:

Multiphysics and multiscale problems exist in many aspects of nature and practical engineering applications. Multiphysics involve multiple physical behaviors to be coupled for an inter-related response. Multiscale problems are to couple physical models at different length or time scales to achieve more precise and accurate description of physical behaviors. To obtain stable, effective, and accurate coupled solutions is not trivial. Traditional methods that are available in commercial software often generate numerical instabilities. To simulate and analyze engineering applications involving multiphysics and multiscales require robust simulation strategy and computational tool. In this talk, I will present the non-boundary-fitted mesh technique used initially in the Immersed Finite Element Method (IFEM) for fluid-structure interactions. I will discuss the evolvement of the immersed finite element method over the years and demonstrate its robustness as a numerical framework and how it can easily couple the physics of any co-existing phases and scales with overlapping meshing or grids represented with different frame of references and written in different numerical codes. The immersed framework has been packaged into an open-source software, OpenIFEM, with cross-platform build, standard testing with modularity, and user documentations. Finally, I will demonstrate its capability by show casing several biomedical and defense applications involving fluid-structure interactions, acoustics-fluid-structure interactions, and solid-solid impacts.

Bio:

Prof. Lucy Zhang is a Professor at the Department of Mechanical, Aerospace & Nuclear Engineering at Rensselaer Polytechnic Institute (RPI) in the US. She is now serving as a Program Director in the CMMI Division at NSF. She is recently named a Fellow of ASME. She received her B.S. from Binghamton University in December of 1997, obtained her M.S. and Ph.D. from Northwestern University, IL in 2000 and 2003, respectively. Upon graduation, she joined Mechanical Engineering Department at Tulane as an assistant professor in July of 2003. In August 2006, she moved to Rensselaer Polytechnic Institute and was promoted to Associate Professor and Professor in 2011 and 2021, respectively.

Her research interests are building advanced and robust computational tools and software for accurate and efficient multiphysics and multiscale simulations that can be used for engineering applications in biomechanics, micro and nano-mechanics, medicine, and defense projects involving impacts. She has published more than 50 highly cited peer-reviewed journals and more than 20 peer-reviewed conference papers. In 2016 she received Young Investigator Award at the International Conference for Computational Methods. Her pioneer work in developing the Immersed Finite Element Method (IFEM) had been and is still being widely used in academic engineering and scientific communities. Prof. Zhang is now developing open-source tools and technology that can conveniently and efficiently couple any existing solvers for multiphysics and multiscale simulations and analysis. She is the show host of "This Academic Life" podcast that is on iTunes, Spotify, Amazon Music, Google Podcasts and Youtube.

Monday, April 18th, 2022   4:00 – 5:20 p.m.

1310 Yeh Student Center