Boulder Fluid and Thermal Sciences Seminar Series

Monday, October 7, 2019
3:00—4:00 PM (refreshments at 2:45)
Bechtel Collaboratory, Discovery Learning Center (DLC 1B70)
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Immersogeometric fluid flow analysis using B-rep CAD models

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Computational fluid dynamics (CFD) simulations of flow over complex objects have been performed traditionally using fluid-domain meshes that conform to the shape of the object. However, creating shape conforming meshes for complicated geometries like automobiles require extensive geometry preprocessing. This process is usually tedious and requires modifying the geometry, including specialized operations such as defeaturing and filling of small gaps. We have developed a new immersogeometric fluid-flow analysis method that directly uses the CAD boundary representation (B-rep) of a complex object and immerses it into a locally refined, non-boundary-fitted discretization of the fluid domain and perform flow simulations. In this talk, I will present our immersogeometric workflow. This includes a new GPU-accelerated voxel-based method to perform point membership classification of the mesh quadrature points, adaptive quadrature rules to faithfully capture the geometry in the intersected elements, and weak enforcement of Dirichlet boundary conditions in the intersected elements. Finally, we have extended our method to directly use analytic surfaces of B-rep CAD models by developing quadrature rules for all four kinds of analytic surfaces: planes, cones, spheres, and toroids. Using analytic surfaces directly avoids unnecessary surface type conversion and significantly reduces model-preprocessing time, while providing the same accuracy for the aerodynamic quantities of interest. We demonstrate the effectiveness of our immersogeometric method for high-fidelity industrial scale simulations by performing an aerodynamic analysis of vehicles directly represented using B-reps.

Biography: Adarsh Krishnamurthy is an assistant professor in the mechanical engineering department at Iowa State University, where he currently leads the Integrated Design and Engineering Analysis (IDEA) lab. Prior to this, he was a post-doctoral researcher in the bioengineering department at UC San Diego and received his Ph.D. in Mechanical Engineering from UC Berkeley. He is the recipient of the NSF CAREER award in 2018 for developing GPU-accelerated tools for patient-specific cardiac modeling. His research interests include computer-aided design (CAD), GPU and parallel algorithms, biomechanics, patient-specific heart modeling, solid mechanics, and computational geometry. His lab is currently funded by the NSF, NASA, NIH and the ONR.