Structural Engineering Seminar Series

CEE 595 S

An Adaptive Immersed Isogeometric Analysis Framework for Multi-Material, Multi-Physics Problems

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Abstract:

In this talk, an adaptive immersed isogeometric analysis framework to predict the response of multi-material, multi-physics problems will be presented. To circumvent the need to generate a body-fitted mesh, the framework instead employs a particular immersed finite element analysis methodology - the so-called extended finite element method - to numerically solve the governing equations using a non-body-fitted mesh. The framework employs hierarchical B-splines to discretize each state variable field, and it can adaptively refine each state variable discretization separately using suitable error indicators to meet field-specific accuracy requirements. Each hierarchical B-spline basis function is separately enriched using a generalized Heaviside enrichment strategy to accommodate arbitrary geometric and material configurations, and a custom stabilization strategy is used to mitigate numerical instabilities that arise in the presence of small cut elements. The efficacy and scalability of the framework will be demonstrated using a suite of elastic and thermo-elastic problems characterized by complex geometries and material layouts as well as large number of materials. To conclude, a new approach to immersed finite element analysis will presented that enables one to transform a classical finite element code into an immersed finite element code with minimal implementation effort, and it will be shown how this approach was leveraged to perform immersed finite element analysis using the popular open-source platform FEniCS.

Bio:

John Evans is an Associate Professor and the Jack Rominger Faculty Fellow in the Ann and H.J. Smead Department of Aerospace Engineering Sciences at the University of Colorado Boulder. His research interests lie at the intersection of computational mechanics, geometry, and approximation theory, with current thrusts in isogeometric analysis, immersogeometric analysis, interactive simulation, and data-driven modeling. He has won a number of awards for his research and teaching including the 2021 Gallagher Young Investigator Award from the United States Association for Computational Mechanics and the 2021 AIAA Rocky Mountain Educator of the Year (College/University), and he is currently Associate Editor of the journal Engineering with Computers.

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1310 Yeh Student Center