An enriched immerso-geometric approach to topology optimization

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Introduction

Topology optimization has emerged as a powerful tool for computational design, enabling the automated generation of optimal structural layouts under prescribed loads and constraints. Traditional approaches, however, rely on fixed structured meshes that can impose significant limitations on problems that require complex evolving topologies that are meant to be smooth.

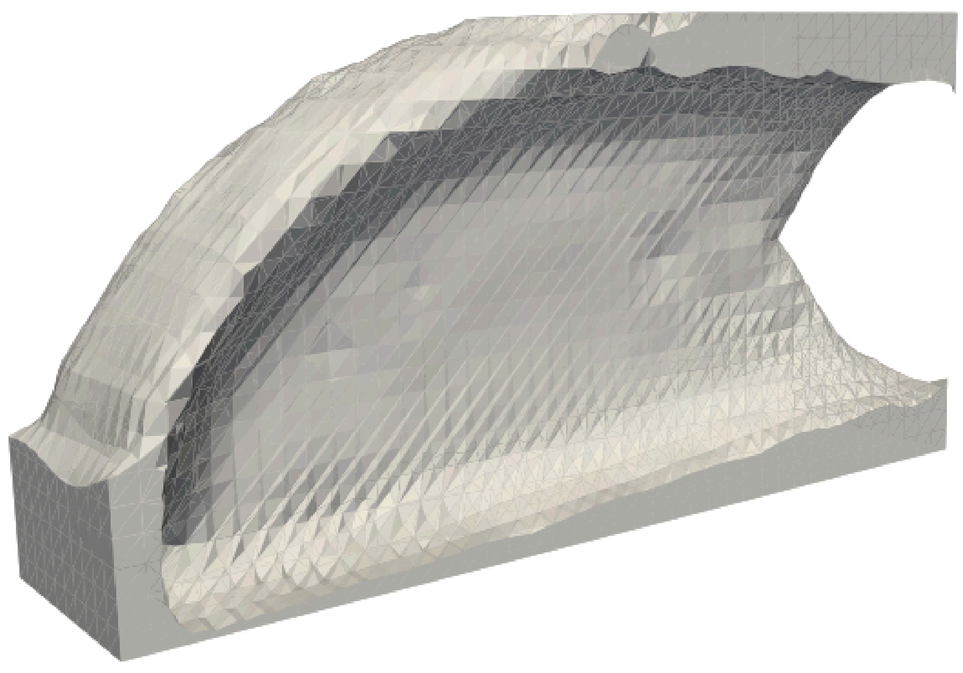
This project will explore a novel methodology for topology optimization using an immersed boundary approach that decouples the design domain from the underlying discretization. To address the challenges associated with accurately capturing material interfaces in such settings, this work investigates the use of interface-enriched generalized finite element methods (IGFEM) in the context of iso-geometric analysis (IGA). IGA offers a unified representation of geometry and analysis using spline-based basis functions, allowing for high geometric fidelity and smooth solution spaces.

By developing IGFEM within the IGA framework, this research aims to enhance the numerical treatment of discontinuities at material interfaces, providing a more robust and accurate foundation for immersed topology optimization. The proposed approach has the potential to significantly improve computational efficiency and design resolution.

The project will involve the formulation, implementation, and numerical testing of this enriched method, with a focus on benchmark problems and performance evaluation against conventional techniques.

Tasks

- Carry out a literature study;
- Build on previous work by the PIs on enriched FEM and IGA;
- Implement and test the novel formulation;
- Write a MSc thesis.



Optimized cantilever beam for minimum compliance using enriched FEM.

Requirements

The student should have the knowledge of discretization methods (e.g., FEM or IGA) and topology optimization, and demonstrated knowledge of Python and/or Julia.

Computational Design and Mechanics

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