Isogeometric Analysis with Parameterization of Arbitrary Topology

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Internship 2014

Scientific context

The management of the geometry is a major bottleneck in simulation of complex systems. The classical approach consists in defining the geometry with high-order representations, such as Non-Uniform Rational B-Splines, in a CAD framework (Computer-Aided Design), while partial differential equation solvers, such as FEA (Finite-Elements Analysis), use grid-based representations. This duality of the geometrical description yields more complex numerical procedures and a loss of accuracy.

To overcome these limitations, the so-called isogeometric analysis was proposed a few year ago, to integrate CAD and FEA frameworks. In this approach, the simulations are carried out using the "exact" CAD representation directly, by solving partial differential equations on parametric volumes instead of grids.

Recently, Galaad and Opale teams have jointly tested this promising approach, but for rather simple problems : the geometry was defined by a single patch or multiple patches with straightforward interfaces. The issue is now to extend these developments to complex and realistic geometries, using an arbitrary topology of the patches.

Internship description

In this perspective, we propose to consider a new parameterization technique developed by Galaad team, which allows to connect patches with an arbitrary topology, while ensuring a G1 regularity at the interfaces. The objective of the internship is to test this geometrical description for isogeometric analysis, in terms of accuracy and computational efficiency.

The work will be composed of the following steps:

1. **Construction of the multi-patch domain for a complex problem.** Applications in aerodynamics are targeted and we propose to consider as typical problem a multi-element wing in take-off configuration, composed of three bodies (slat, main wing, flap).

2. **Extension of the partial differential equation solver to such computational domains.** For the sake of simplicity, we will consider a potential flow model, which corresponds to a simple extension of the existing elliptic solver implemented in Axel platform (developed by Galaad team).

3. **Numerical tests.** The accuracy of the proposed method will be quantified by refinement study.

Requirements

- MSc (Master) in Applied Mathematics, Engineering or Scientific Computing.
- Experience in Computational Geometry or Partial Differential Equations.
- C/C++ programming language.

Salary

Average net salary of 1100 €/month.

Duration

Duration 5 months.

Contacts

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