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PROPOSITION DE SUJET DE THÈSE

Intitulé : A novel immersed shell method for airplane concepts

Référence : **SNA-DTIS-2025-31**
(à rappeler dans toute correspondance)

Début de la thèse : 01/10/2025	**Date limite de candidature : 01/06/2025**

Mots clés

CAD, shell, CutFEM, immersed geometry, higher order, finite element method

Profil et compétences recherchées

Master 2 ou école d'ingénieur

Mathématiques appliquées, méthodes numériques pour les EDP, méthode des éléments finis

Présentation du projet doctoral, contexte et objectif

New wing or airplane models are typically first designed in a CAD software. These CAD models are a composition of surfaces described by spline functions (2D curves in embedded 3D). To create a finite element model from this CAD geometry, these surface splines have to discretised into surface meshes. This process is often error-prone and requires manual interventions because the resulting surface meshes require well-shaped triangles. Another disadvantage of this discretization process is the loss of the smooth surface representation.

In this thesis, we suggest to develop a novel immersed finite element method in which we take the surface representation from CAD directly and embed it in a regular finite element mesh. The regular finite element mesh is then used to discretize the shell equations while keeping the surface description smooth.

This approach is challenging in two ways. Firstly, we need to develop a stabilization scheme to ensure the stability and accuracy of the finite element solutions [1] and secondly, we need to develop an adapted shell model. In contrast to classical shell models in which local coordinates on the surfaces are used, we will develop a shell model based on projecting differential operators onto the surface based on the work of Hansbo et al. [2].

All the theoretical developments, will be accompanied by the development of a parallelized high performance code in python and C++ in the software package CutFEMx (https://github.com/sclaus2/CutFEMx).

[1] Burman, E., Claus, S., Hansbo, P., Larson, M. G., & Massing, A. (2015). CutFEM: discretizing geometry and partial differential equations. *International Journal for Numerical Methods in Engineering*, *104*(7), 472-501.

[2] Hansbo, Peter, and Mats G. Larson. "Finite element modeling of a linear membrane shell problem using tangential differential calculus." *Computer Methods in Applied Mechanics and Engineering* 270 (2014): 1-14.

Collaborations envisagées

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