# Mesh Adaptation by Local Modifications for Discontinuous Galerkin Immersed Boundary Methods

**Marco Lorini* and Mario Ricchiuto***

*Inria Bordeaux Sud-Ouest, Team CARDAMOM
200 rue Vieille Tour, 33405 Talence, France
e-mail: marco.lorini@inria.fr, mario.ricchiuto@inria.fr

## ABSTRACT

Nowadays anisotropic mesh adaptation has largely proved useful in the context of numerical simulations in order to reduce the computational cost and/or to capture the physical behavior of a complex phenomenon. However the generation of suitable body-fitted meshes for high-order methods is still considered a bottleneck for their process chain, thus limiting their routine use in large-scale industrial applications.

An attractive alternative to the classical conformal meshing approach is the use of unfitted discretizations, which are gaining popularity mainly because they simplify the mesh generation process, particularly in the case of moving bodies. This kind of methods are in fact characterized by a mesh that covers the entire domain, not conforming to the geometry of immersed bodies. A modification of the governing equations in the vicinity of the bodies is clearly needed to incorporate the boundary conditions and leads to the the well-known difficulties of unfitted methods in giving an accurate definition of the solid boundaries, not explicitly discretized.

Our project on Immersed Boundary Methods (IBM) combines several techniques and always aims at being first of all geometrically flexible, thus the choice of working since the beginning in the Discontinuous Galerkin (DG) framework. The localization of the immersed solid bodies is done, for the same reason, via a Level-Set (LS) method, employing the signed distance function. A metric-based anisotropic mesh adaptation on simplicial meshes is employed to overcome the above mentioned IBM's limitation, leading to a refinement of the mesh close to the solid boundary, and to improve the quality of the global solution. To this end a metric tensor is defined at each node through simultaneous reduction in order to intersect a LS metric (the one proposed in [1]) and the metric proposed in [2] for flow feature adaptation. Furthermore, an high-order representation of the mesh edges in the vicinity of the zero-isovalue of the LS is obtained using the discrete representation of the gradient of the LS function to project the added mid-nodes to the curved (embedded) boundary.

The presentation will give an overview of the latest results of the project. We will briefly cover the motivations and scope of the work before describing in full detail our method and the mesh adaptation strategy. Some details on the DG discretization and the implementation of the method in our solver will be also given. Results on two- and three-dimensional test cases will conclude the presentation.

## REFERENCES

[1] C. Dapogny and P. Frey, "Computation of the signed distance function to a discrete contour on adapted triangulation", *Calcolo*, Vol. **49** (3), pp. 193-219, (2012).

[2] P. Frey and F. Alauzet, "Anisotropic mesh adaptation for CFD computations", *Comput. Methods Appl. Mech. Engrg.*, Vol. **194**, pp. 5068-5082, (2005).