Post-doc proposal - Year 2018

Isogeometric Discontinuous Galerkin method

Inria Sophia Antipolis - Méditerranée Research Center
Acumes Project-Team
2004 Route des Lucioles, BP 92, 06902 Sophia Antipolis Cedex, France

Context

Acumes Project-Team (http://team.inria.fr/acumes) is a joined team from Inria Sophia Antipolis - Méditerranée Research Center and mathematics laboratory Jean-Alexandre Dieudonné at University of Nice. The research conducted concerns the analysis and optimization of systems governed by partial differential equations, with applications ranging from fluid and structural mechanics to modeling of biological phenomena, road and pedestrian traffic. in this context, the development of efficient numerical schemes plays a major role in the team.

For some years, a new simulation paradigm has been emerging, the *isogeometric analysis*, which consists in solving partial differential equations by a variational approach, using NURBS (Non-Uniform Rational B-Spline) bases originating from CAD (Computer-Aided Design) domain. This approach has the advantage to allow a resolution without geometrical approximation, i.e. with a computational domain supported *exactly* by the CAD geometry, contrary to classical mesh-based methods that approximate the geometry by local linearization. Consequently, isogeometric analysis relies on a unique high-order representation for both the geometry and the fields to solve, yielding a significant gain in terms of accuracy and ease of interaction. This approach has been popularized by T. Hughes [CHB09], mainly for elliptic and parabolic problems.

Acumes Project-Team has recently proposed a formulation dedicated to hyperbolic problems, based on a Discontinuous Galerkin (DG) method [Duv18]. This approach has been applied to compressible aerodynamics in the context of Euler, and then Navier-Stokes, equations including strategies for local refinement and shock capturing, for some 2D academic cases.

Objective

We propose to extend this work to more demanding problems of industrial complexity. Two points will be considered: first, the construction of the computational domain using NURBS patches for complex geometries. Then, the extension of the isogeometric DG solver to allow 3D simulations. The accuracy of the proposed approach will by especially investigated, including comparison with classical mesh-based methods. The gain of using a high-order and geometrically exact computational domain will be quantified.

Work to achieve

The post-doctoral fellow will be part of the Acumes Project-Team at Inria Sophia Antipolis - Méditerranée Research Center. At first, he will have to become familiar with the isogeometric DG method and the specificities related to the use of NURBS patches to represent the computational domain. A first part of the work will consist in proposing an algorithm to automatically construct the computational domain, by using subdivision techniques specific to NURBS patches, starting from an initial domain. Second, he will study the extension of the isogeometric DG method to 3D problems.

On the basis of the existing code (C++ language, MPI) solving Euler/Navier-Stokes equations on NURBS domains, the post-doctoral fellow will implement the proposed approaches and will conduct a set of numerical tests based on industrial problems, in order to qualify the methods and quantify their accuracy. The targeted applications concern compressible flows around turbine blades.

Profile

The candidate must hold a PhD thesis in scientific computing / applied mathematics. Knowledge in C++ is required. An experience in mesh construction and adaption, high-performance computing, high-order schemes is a plus.

Director: Regis Duvigneau

Contact: regis.duvigneau@inria.fr

Link: `http://team.inria.fr/acumes`

Duration: 16 months

Location: Inria Sophia Antipolis - Méditerranée Research Center

Salary: around 2600€(without tax)

References

[CHB09] J.A. Cottrell, T.J.R. Hughes, and Y. Bazilevs. *Isogeometric analysis : towards integration of CAD and FEA*. John Wiley & sons, 2009.

[Duv18] R. Duvigneau. Isogeometric analysis for compressible flows using a Discontinuous Galerkin method. *Computer Methods in Applied Mechanics and Engineering*, 333(443–461), 2018.