2018-00489 - [PostDocPREGeoSim-ACUMES] Isogeometric Discontinuous Galerkin method

Level of qualifications required : PhD or equivalent
Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) "Université Côte d'Azur (UCA)".

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.


Assignment

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 be especially investigated, including comparison with classical mesh-based methods. The gain of using a high-order and geometrically exact computational domain will be quantified.

General Information

- Theme/Domain : Numerical schemes and simulations
- Town/city : Sophia Antipolis
- Inria Center : CRI Sophia Antipolis - Méditerranée
- Starting date : 2018-11-01
- Duration of contract : 1 year, 4 months
- Deadline to apply : 2018-05-27

Contacts

- Inria Team : ACUMES
- Recruiter : Duvigneau Regis / regis.duvigneau@inria.fr

The keys to success

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.

Conditions for application

Before to apply, and preferably before may 20th, it is strongly recommended to contact the scientific in charge of this offer.

Defence Security :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorization to enter an area is granted by the director of the unit, following a favourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website.
Main activities
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.

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
Gross Salary: 2650 brutto per month