A propos du centre ou de la direction fonctionnelle

Located at the heart of the main national research and higher education cluster, member of the Université Paris Saclay, a major actor in the French Investments for the Future Programme (Idex, LabEx, IRT, EquipeX) and partner of the main establishments present on the plateau, the centre is particularly active in three major areas: data and knowledge; safety, security and reliability; modelling, simulation and optimisation (with priority given to energy).

The 450 researchers and engineers from Inria and its partners who work in the research centre’s 28 teams, the 60 research support staff members, the high-level equipment at their disposal (image walls, high-performance computing clusters, sensor networks), and the privileged relationships with prestigious industrial partners, all make Inria Saclay Île-de-France a key research centre in the local landscape and one that is oriented towards Europe and the world.

Contexte et atouts du poste

The postdoc will be held at Inria Saclay - Île-de-France in the Gamma team-project under the supervision of Frédéric Alauxet.

The work will be done in collaboration with Boeing and Safran Tech that are users of the mesh adaptation technology.

Mission confiée

The aim of mesh adaptation is to generate the best mesh to perform a specific numerical simulation. It results in a powerful methodology that reduces significantly the size of the mesh required to reach the desired accuracy. Thus, it impacts favorably the simulation CPU time and memory requirement. Moreover, as the generated adapted mesh is in agreement with the physics of the flow, for some applications, this is the only way to obtain an accurate prediction of the flow. Nowadays, mesh adaptation is a mature tool which is well-posed mathematically. And, as it is fully automatic, it has started to be used in industrial R&D departments. Indeed, it has already proved, throughout many publications and applications, its superiority with respect to fixed mesh. However, simulating complex physical phenomena on complex 3D geometries (such as high-lift applications or turbomachinery applications), which is more and more required by industry, still remains a challenge. Indeed, high-fidelity prediction for such numerical simulations requires large size meshes (hundreds of millions elements) even if anisotropic mesh adaptation is considered.

A quicker response of the adaptative process requires a parallelization of the full platform, i.e., the parallelization of the flow solver, the error estimator, the local remesher and the interpolation stage. This also requires a proper mesh partitioning which is optimal for each stage of the mesh adaptation loop.

A first step in this direction has been done with the shared-memory parallelization of the whole solution-adaptive simulation platform using a shared-memory parallelization library developed in the team the LPbC. An overall (real time) strong speed-up between 10 and 15 on twenty cores is usually achieved on industrial applications.

A second step has been achieved with the distributed-memory parallelization of the local remesher and the development of an efficient mesh partitioning which takes into account the remesher work load. With this strategy, we were able to generate, for a model problem, 2 billion elements in 15 minutes on 100 processors. But, this has been done outside of the solution-adaptive platform.

The goal of this Post Doctoral position is to finalize the distributed-memory parallelization of each stage of the mesh adaptation loop and to design optimal transition between each stage as mesh repartitioning will be required to obtain balance work load at each step.

The postdoc will first learn all the concepts related to mesh adaptation. He/she will perform several 3D adaptive simulations of inviscid and viscous flows to become familiar with the Inria solution-adaptive simulation platform involving a flow solver, an adaptive mesh generator, an error estimate code and an interpolation code.

Once familiar with the mesh adaptation platform, the postdoc will work on the parallelization with MPI of the flow solver, the error estimate and the solution interpolation software. For each tool, we will analyze in detail the obtained strong speed-up and will set-up the optimal hybrid parallelization using shared-memory and distributed memory techniques. We will also enhance the mesh partitioning code to obtain an optimal load balancing and to output appropriate partitions (ghost cells, ...), for each tool.

The next step will be to link all the tools involved in the solution-adaptive simulation platform and to analyse deeply the obtained strong speed-up. This may lead to work on the development of parallel IO's in the LoMesh library.

The developed methodology will be validated on several industrial problems in aeronautics and turbomachinery and will be run on Inria Saclay Île-de-France cluster composed of 1000 processors. In aeronautics, in collaboration with Boeing, we will focus of drag and high-lift prediction applications. In turbomachinery, in collaboration with Safran, we will focus on compressor and stator simulations.

As one can see, in this postdoc, the work will be confronted to advanced scientific computing issues (numerical schemes, fast and efficient implementation of the numerical methods, parallel computing...).
Main activities (5 maximum):

- Develop distributed memory parallelization in the flow solver, the error estimate and the interpolation tools
- Pursue the development of the mesh partitioning tool
- Set-up the full distributed memory solution-adaptive simulation platform
- Analyze the strong scalability of the full distributed memory solution-adaptive simulation platform
- Participate to the collaboration with Boeing and Safran

Further information below:
https://zimbra.inria.fr/service/home/~/?auth=co&loc=fr&id=403116&part=2

Compétences

A PhD in scientific computing is required to apply for this position.

Knowledge on MPI and finite volume methods is also mandatory.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Rémunération

Monthly gross salary : 2.653 euros