Postdoctoral Fellowship
Numerical Methods and Anisotropic Mesh Adaptation for RANS and LES Simulations
(MOST Team, LEGI, Grenoble)
Duration: 18 months, renewable.

Scientific Background

The relevance of numerical simulations of turbulent flows relies on achieving an optimal balance between accuracy and computational cost. Reynolds-Averaged Navier–Stokes (RANS) and Large-Eddy Simulation (LES) approaches provide different levels of fidelity at computational costs suited to a wide range of applications. Beyond turbulence modeling itself, their accuracy and efficiency depend strongly on the numerical methods employed and on the quality and suitability of the computational mesh.

For several years, the MOST team (Modeling and Simulation of Turbulence) at LEGI has been developing automatic mesh adaptation strategies for DNS, LES, and RANS simulations within the YALES2 code. These approaches are based on physically motivated criteria to ensure that the mesh is consistent with the requirements of the selected turbulence modeling approach.

Recent results have demonstrated the potential of this methodology to optimize meshes and reduce the dependence of simulation results on user choices made during mesh generation. However, several scientific and numerical challenges remain open regarding the interaction between numerical methods and meshes: effective accuracy of numerical schemes on highly anisotropic meshes (including high-order methods), preprocessing of mesh metrics (e.g., mesh gradation) to satisfy numerical constraints, robustness of pressure–velocity coupling for incompressible flows, conservation of physical quantities during remeshing and interpolation operations, and more.

Objectives of the Postdoctoral Project

The objective of this postdoctoral project is to gain a deeper understanding of the interactions between numerical methods, anisotropic mesh adaptation, and turbulence modeling, with the aim of developing a robust and accurate simulation framework for RANS and LES calculations in YALES2.

The work will combine the analysis of limitations currently observed on highly anisotropic meshes with the development of new numerical approaches to fully exploit their potential. Particular attention will be paid to the effective accuracy of discretization schemes on anisotropic meshes, the consistency of pressure–velocity coupling, the conservation of quantities during remeshing operations, and the robustness of the RANS solver.

The project will also investigate the influence of the order of numerical schemes on the optimal mesh metric, as well as the determination of appropriate time steps when semi-implicit time-integration strategies are used. The ultimate goal is to establish design principles ensuring an optimal match between numerical methods, mesh resolution, and turbulence modeling, in order to maximize simulation accuracy for a given computational cost.

Working Environment

The successful candidate will benefit from a highly recognized scientific environment, access to high-performance computing resources, and strong interactions with both academic and industrial partners.

Candidate Profile

- PhD in fluid mechanics, physics, applied mathematics, or a related field,
- Experience in numerical simulation and/or modeling and/or data science,
- Strong interest in collaborative research.

Application Procedure

Applicants should send the following documents by email (manuel.bernard@univ-grenoble-alpes.fr): CV, list of publications, Cover letter, Contact information for references.

Contact

For any questions or informal discussion, candidates are encouraged to contact Manuel Bernard at manuel.bernard@univ-grenoble-alpes.fr.