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MESH ADAPTATION FOR FLOW SIMULATION

A. GARGALLO-PEIRÓ, J. DOCAMPO-SÁNCHEZ AND O. LEHMKUHL

Barcelona Supercomputing Center
Plaça Eusebi Güell, 1-3
08034 Barcelona (Spain)

ABSTRACT

The demand for advanced Computational Fluid Dynamics (CFD) tools to meet modern engineering design challenges continues to grow rapidly. In industries such as aerospace, automotive, and energy, there is a pressing need to re-engineer CFD solvers to fully exploit the potential of extreme-scale parallel computing platforms. This mini-symposium on Mesh Adaptation for Flow Simulation will gather experts to explore recent breakthroughs in mesh refinement, metric-based adaptation, and remeshing, with a special emphasis on industrial applications like wind resource assessment or high-lift aerodynamics for aircraft design.

Key topics include:

1. **Adaptive Mesh Refinement (AMR) and Metric-Based Adaptation:** Addressing challenges in dynamically refining, coarsening, and aligning anisotropic meshes (e.g., Hessian/error-metric driven, octree-based AMR) to improve CFD accuracy and efficiency. Focus includes applications across RANS, Scale-Resolving Simulations (LES/DES), and complex geometries.
2. **Mesh Adaptation for High-Order Schemes:** Advancements tailored for low-dissipation, high-order discretization methods (p-refinement, Discontinuous Galerkin, high-order FV/FE). These methods enhance accuracy in both incompressible and compressible flows, particularly in turbulent boundary layers and aerodynamics.
3. **Data-Driven & AI-Guided Adaptation:** Machine learning and AI frameworks used to steer mesh adaptation in CFD. Topics include feature detection via statistical methods, reinforcement learning for optimal mesh distribution, and data-driven turbulence modeling.
4. **Industrial Case Studies & HPC Scalability:** Real-world applications of large-scale adaptive simulations across aeronautical, automotive, and wind energy sectors, highlighting execution on extreme-scale computing architectures.

The symposium aims to advance the conversation on mesh adaptation by bringing together innovative numerical techniques, HPC applications, and industrial case studies.