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AN OVERSET GRID STRATEGY FOR AEROACOUSTICS AND AEROELASTICITY OF MOVING BODIES

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ABSTRACT

The coupling between fluids and moving bodies is a key step for current applications in energy industry such as aeroacoustics (aeolian tones of cables) and aeroelasticity (Vortex Induced Vibrations (VIV) of bluff bodies [7], blade flutter [2]). Two approaches are mainly used, the classical ALE method associated with deforming and/or remeshing procedures, and the overset grid (Chimera) method, with different body-fitted overlapping grids associated with interpolation procedures for the communication between component grids. If one wants to adress phenomena with fluid/acoustic interactions, high order discretisation methods and high quality grids are required to prevent both the dissipation and the dispersion of the acoustic field. In this context, the use of overset strategy on structured grids allows body displacements while preserving grid quality.

The present numerical simulations are performed with the parallel SAFARI code (Simulation of Aeroacoustic Flows And Resonance and Interaction) [3], which solves the unsteady compressible Navier-Stokes equations in general time-dependent curvilinear coordinates. Fluxes and derivatives in the viscous terms are discretized by an optimized centered 11-point finite difference scheme in conjunction with an optimized explicit 11-point low pass filter [1] to remove grid-to-grid oscillations. The time integration is performed via a standard explicit fourth-order low-storage Runge-Kutta scheme. This high-order algorithm is extended to general overset grid topologies in order to handle complex configurations as those including multiple bodies. Following Sherer and Scott [8], high-order explicit non-optimized Lagrangian polynomials are used to perform the interpolation between overlapping grids. To do so, the SAFARI code is interfaced with the freely available *Overture* library [6]. This numerical tool makes it possible to retrieve flow/acoustics coupling [4] in compressible flows. To tackle fluid/structure interactions, the algorithm is extended to moving/deforming grids using the overset strategy. The evaluation of the time metrics used by Visbal et al. [9] is retained to satisfy the geometric conservation law.

The coupling between the fluid and the structure is done via an explicit staggered procedure [5]. To maintain time accuracy, the procedure is applied at each stage of the Runge-Kutta scheme and the interpolation data used for the communications between the component grids are updated as well.

2D low Reynolds number computations are presented. The flow arround a fixed cylinder is first assessed. Then the coupling procedure and forced oscillations are adressed. Finally, the radiated acoustic field generated by VIV is computed for several mean flows and its behaviour at lock-in is investigated.

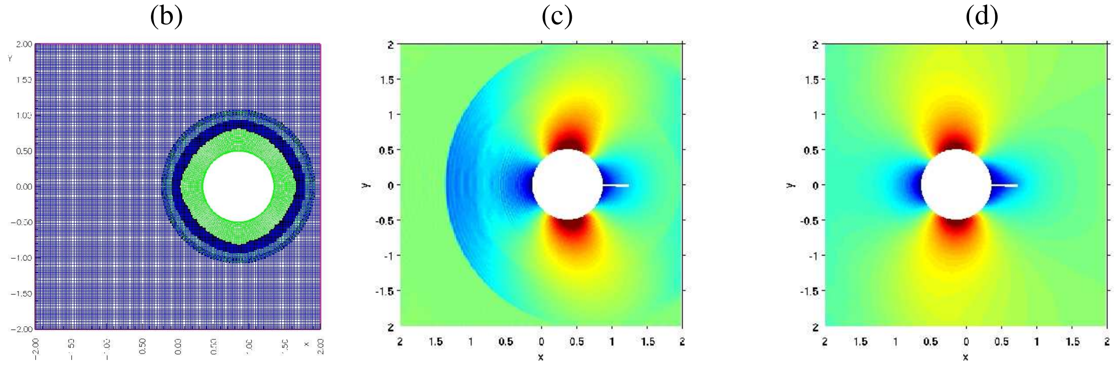

Figure 1: 2-D inviscid flow around a moving cylinder; (a): general view of the computational domain, (b),(c) and (d): time evolution of the streamwise velocity around the cylinder.

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