On Conservation in Compressible Flow Simulations Using Sliding Mesh Coupling

Giulio Gori[†,*], Edwin van der Weide[‡] and Alberto Guardone[†]

[†] Department of Aerospace Science and Technology, Politecnico di Milano
Via La Masa 34, 20156 Milano, Italy, e-mail: giulio.gori@polimi.it

[‡]Department of Mechanical Engineering, University of Twente, CTW Faculty
7500 Enschede, The Netherlands

ABSTRACT

In Computational Fluid Dynamics (CFD), sliding mesh approach represents a fundamental tool to deal with unsteady problems involving bodies in relative motion. Typical example are found in turbomachinery (i.e. internal flows across rotor and stator blades) or aerospace (i.e. helicopter rotors or aircraft propellers) applications.

In this paper, a througout analysis of flux conservation at the non-conformal interface between moving grids is presented for two different approaches characterized by increasing complexity. Both procedures result in a loosely coupled problem: the fluid dynamic equations are solved independently over each grid. In order to enforce the coupling between different zones, the sliding interface is assumed to act as a boundary onto which a non-uniform outer state is applied. At each iteration, the outer state is locally retrieved as a linear combination of the thermodynamic states of adjacent elements belonging to neighbouring grids.

In the simpler approach, the outer state is assumed to be locally equal to the state of the nearest node within the neighbouring zones. In the more advanced approach, proposed by Rinaldi in [1], a supermesh patch is first constructed over the sliding interface. For each boundary element, the numerical flux across the interface is then computed as a weighted average of the fluxes from all the elements of the neighbouring zone that share the same portion of the supermesh interface.

The conservation of fundamental quantities such as mass, momentum and energy across the sliding interface is evaluated for several exemplary test cases. These include steady and unsteady flows across non-conformal stationary grids and steady problems involving rotating meshes.

Results highlight advantages and weaknesses of the approaches considered in this work. For both methods, flux conservation is proved to be strictly guaranteed only for a limited set of problems.

REFERENCES

[1] Rinaldi, E. and Colonna, P and Pecnik, R. Flux-conserving treatment of non-conformal interfaces for finite-volume discretization of conservation laws. *Comp. Fluids* (2015) **120**:126-139.