11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

PARALLEL DATA TRANSFER ACROSS SLIDING PLANE FOR UNSTEADY SIMULATIONS OF MULTISTAGE TURBOMACHINERY FLOWS

V. Ganine*, **D. Amirante and N. Hills**

Fluids Research Center,
Faculty of Engineering and Physical Sciences,
University of Surrey,
Guildford, Surrey GU2 7XH, UK.
v.ganine@surrey.ac.uk

Key words: *Computational Fluid Dynamics, Rotor-Stator Interaction, Relative Grid Motion, Sliding Mesh Interface, Unstructured Grids, Parallel Performance, High-Performance Computing.*

Parallel distributed scientific and engineering applications for solving partial differential equations involve transfer of data across natural or artificial spatial interfaces between individual processing units. This transfer is significantly complicated by the fact that the interacting components may employ different physical models and computational approaches, a wide range of spatial and temporal scales or non-matching discretizations. In many situations even the relative position of the components that share a spatial interface may evolve in time. These difficulties place extreme demands on the data transfer technology [1].

High fidelity simulation of flow phenomena around complex geometries for turbo-machinery applications requires fluid solvers to run on ever increasing processor counts [2]. For fully unsteady predictions in rotor-stator systems most CFD codes often employ the sliding interface techniques [3, 4, 5].

The scalability and efficiency of current sliding grid parallel implementations are significantly constrained by the computation and communication imbalances associated with data transfer across discrete non-matching interfaces. To prepare for the challenges at extreme scales in this paper we attempt to redesign the algorithm in such a way that it maintains the scalability of original CFD codes on static grids. In the proposed parallel implementation the cell containment search and interpolation workloads are balanced by employing a deterministic geometric decomposition on an intermediate "rendezvous" set of processes. Rapidly changing dynamic communication patterns induced by grids relative motion are handled with a sparse communication protocol. The scaling behavior of the developed method is analyzed on an industrial turbine test case.

REFERENCES

[1] Keyes K, McInnes L, Woodward C, Gropp W, Myra E, et al. Multiphysics simulations: Challenges and opportunities. *International Journal of High Performance Computing Applications* 2013; **27**(1):4–83.

[2] Tucker P. Computation of unsteady turbomachinery flows: Part 1 progress and challenges. *Progress in Aerospace Sciences* 2011; **47**(7):522–545.

[3] Fenwick C, Allen C. Development and validation of sliding and non-matching grid technology for control surface representation. *Proceedings of the Institution of Mechanical Engineers, Part* G*: Journal of Aerospace Engineering* 2006; **220**:299–315.

[4] Blades E, Marcum D. A sliding interface method for unsteady unstructured flow simulations. *International Journal for Numerical Methods in Fluids* 2007; **53**:507–529.

[5] Steijl R, Barakos G. Sliding mesh algorithm for CFD analysis of helicopter rotor-fuselage aerodynamics. *International Journal for Numerical Methods in Fluids* 2008; **58**:527–549.