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

VERIFICATION OF AN OVERSET FLUID-STRUCTURE INTERACTION SOLVER

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Key words: *Fluid-Structure Interaction, Code Verification, Arbitrary Lagrangian-Eulerian, Overset Methods, Finite Volume, Finite Element.*

Rigorous code verification of a previously developed overset-grid enabled Fluid-Structure Interaction (FSI) algorithm [1] is presented and discussed. A collection of best practices for verifying partitioned FSI codes are also presented. Specifically, the method of manufactured solutions (see, e.g., [2]) is used to determine the order of accuracy of the ARL/PSU FSI code, including convergence rates and error magnitudes. The partitioned FSI algorithm introduces separate discretization schemes for the solid, fluid, and mesh motion components, requiring special care in the definition of a comprehensive verification exercise. Additionally, the sources of discretization error from each component of the solver must be combined into a single metric to determine global convergence rates.

Our strategy is to first verify each solver component independently, then reduce the verification exercise to one in which a global parameter is adjusted. This global parameter must be defined in order to capture the relative sources of error across the domain and motivates an optimal mesh refinement ratio between the fluid and solid domains. The error between exact and computed solutions can therefore be calculated over the entire fluid-structure domain, as well as the individual fluid and solid components. For example, the mesh size of the fluid domain can be chosen as the primary parameter of error characterization, and the subsequent adjustment of solid mesh and time step size produces a solution that is globally of the same order of accuracy. Special attention is given where overset grids are present, as the interpolation involved can significantly impact solution quality. Presented results include error magnitudes, convergence rates, and methodologies for a coherent approach to employing the method of manufactured solutions to partitioned FSI codes.

REFERENCES

[1] Miller, S., R.L. Campbell, C.W. Elsworth, J.S. Pitt, D.A. Boger. An Overset Grid Method for Fluid-Structure Interaction. *International Journal for Numerical Methods in Fluids*. Submitted October 28, 2013.

[2] P. J. Roache. Verification and Validation in Computational Science and Engineering. Hermosa Publishers. Albuquerque, NM, 1998.