Dynamic Overset Grid Implementation in OpenFOAM

David A. Boger, david-boger@psu.edu **Ralph W. Noack,** rwnoack@psu.edu **Eric G. Paterson**, egp11@psu.edu	The Pennsylvania State University Applied Research Laboratory P.O. Box 30 State College, PA 16804-0030

Abstract

A dynamic overset grid capability has been implemented in OpenFOAM with the aim of enabling complex flow simulations pertaining to surface ship sea-keeping, multibody interactions for underwater vehicles, rotorcraft, and more. The supporting classes compile into a library that we refer to as "foamedOver." It stands separately from OpenFOAM in the sense that no modifications have been made to the OpenFOAM library itself, and it inserts easily into solvers in both the 1.5-dev and 1.6.x versions of OpenFOAM. The overset assembly may be static or dynamic. In the latter case, any number of dynamic bodies are allowed, and the motion of each body can be specified individually as being either subject to 6DOF equations of motion, prescribed by state history interpolation tables, or programmed into run-time selectable objects.

The implementation benefits significantly from several other software packages, including Suggar++ [1], DiRTlib [2], and PETSc [3]. Suggar++ is the software responsible for the overset grid assembly, including the hole-cutting, donor search, and overlap minimization. Suggar++ supports a wide range of grid and flow solver types , including direct support for dynamic unstructured grids and cell-centered flow solvers. It can be compiled into both a stand-alone executable and shared object file. Here the latter form was used so that it could be called directly from within the flow solver at each time step. DiRTlib is a "solver-neutral" library that simplifies the addition of an overset grid capability to a flow solver by encapsulating commonly needed operations such as the handling of the domain connectivity information from the overset assembly software and the gathering of data from the donor cells to the receptors and subsequent interpolation. PETSc is a suite of data structures and routines for the parallel solution of large systems of linear and non-linear equations [3]. PETSc was used to facilitate the construction and solution of the linear systems of equations, which were modified to account implicitly for the intergrid boundary conditions. So for example, the pressure equation is normally solved using the default preconditioned GMRES solver in PETSc. The momentum equations, on the other hand, are normally solved using a weighted Jacobi scheme [4].

In addition to presenting some details of the implementation, the presentation will review some applications and early validation efforts. Results will be shown for solutions based on a variety of the packaged tutorials and solvers (e.g. potentialFoam, icoFoam, and interDyMFoam) .

Key words: Overset, OpenFOAM

References

[1] Ralph W. Noack, David A. Boger, Robert F. Kunz, and Pablo M. Carrica, *Suggar++: An Improved General Overset Grid Assembly Capability*, AIAA Paper 2009-3992, 19th AIAA Computational Fluid Dynamics Conference, San Antonio, TX, 22-25 June 2009.

[2] Ralph W. Noack: *DiRTlib: A Library to Add an Overset Capability to Your Flow Solver*, AIAA Paper 2005-5116, 17th AIAA Computational Fluid Dynamics Conference, Toronto, Ontario, Canada, 6-9 June 2006.

[3] Satish Balay, Kris Buschelman, William D. Gropp, Dinesh Kaushik, Matthew G. Knepley, Lois Curfman McInnes, Barry F. Smith, and Hong Zhang: *PETSc Web page*, http://www.mcs.anl.gov/petsc, 2009.

[4] R.F. Kunz, B.W. Siebert, W.K. Cope, N.F. Foster, S.P. Antal, and S.M. Ettorre: *A Coupled Phasic Exchange Algorithm for Multi-Dimensional Four-Field Analysis of Heated Flows with Mass Transfer*, Computers and Fluids, 27(7) 741-768, 1998.