AN EFFICIENT IMPLICIT COUPLING SCHEME FOR PARALLEL MULTI-PHYSICS SIMULATIONS WITH APPLICATION TO SOLID ROCKET MOTORS

A. Namazifard[a,b] , **X. Jiao**[b], **J. Blazek**[b] and **K.D. Hjelmstad**[c]

[a]corresponding author
243 Engineering Sciences Building
1101 West Springfield Avenue
Urbana, IL 61801
namazifa@uiuc.edu

[b]Center for Simulation of Advanced Rockets
University of Illinois at Urbana-Champaign

[c]Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign

We describe a modified implicit algorithm to couple different physics modules in solid rocket motors simulations. Our simulation code takes a partitioned approach to system integration in which each physics module (i.e., fluid, structure or combustion) solves on its own domain and any jump conditions between them are held at the interfaces between domains. We employ predictor-corrector iterations to treat the fluid-structure interaction. We also present a hybrid implicit-explicit coupling scheme, which takes advantage of the efficiency of explicit methods and accuracy of implicit methods.

The implementation of jump conditions involves operations such as manipulating data on some interface mesh and transferring data between different meshes. These additional operations are independent of the physical modules and are provided by the service components. Our framework provides a flexible mechanism for inter-module data exchange and function invocation in parallel multi-physics simulations. It allows rapid prototyping of various coupling algorithms and plug-and-play of different implementations of physics and computer science modules in an integrated system.

Parametric and convergence studies are presented to demonstrate the efficiency and reliability of our approach and results from simulation of the Titan IV solid rocket motor demonstrate the applicability and parallel performance of our code.