Fully Coupled Monolithic Implicit Immersed Finite Element Formulations for Fluid-Solid Interactions

X. Sheldon Wang*

* Professor, McCoy School of Engineering
Midwestern State University
3410 Taft Blvd, Wichita Falls 76308, Texas, USA
e-mail: sheldon.wang@mwsu.edu, web page: http://faculty.mwsu.edu/engineering/sheldon.wang/

ABSTRACT

In this paper, we explore the pros and cons of fully coupled monolithic implicit immersed finite element formulation for fluid-solid interaction (FSI) problems. A brief overview will be provided to illustrate the concept of immersed finite element methods and heritage of the immersed boundary method and the fictitious domain method. Basic data structures of the program (in Fortran 90) with respect to the matrix free Newton-Krylov iteration, ghost grids for efficient search algorithm, mixed finite element formulations for compressible fluid and solid domains, and respective meshing requirements will also be presented. Model reduction methods based on fully coupled monolithic approaches for FSI problems will be discussed with the context of Singular Value Decomposition of the covariance matrix and the corresponding Krylov space constructed with judiciously chosen time snapshots. The traditional Mode Superposition Method for linear FSI problems will be reviewed as a comparison.

Finally, we will also discuss the possibility of using the multigrid concept as one of the pre-conditioner for the further improvement of computational efficiencies.

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