Fluid Structure Interaction by Means of Variational Multiscale Reduced Order Models

Alexis Tello, Ramon Codina and Joan Baiges
Universitat Politècnica de Catalunya, Barcelona, Spain

In this work we develop a Reduced Order Model (ROM) for Fluid-Structure Interaction (FSI) problems, assuming that the Full Order Model (FOM) corresponds to the finite element approximation of the continuous problem. The solid is assumed to be a neo-Hookean material subject to large strains and written using an updated Lagrangian approach, whereas domain motion of the Newtonian fluid interacting with it is treated with an Arbitrary Lagragian-Eulerian (ALE) formulation. Finite elements are used to approximate both problems, with an irreducible displacement approach for the solid and a stabilized velocity-pressure formulation for the fluid. The ROM is obtained through a Proper Orthogonal Decomposition (POD), which is built from snapshots of the FOM corresponding to both the solid and the fluid problems. We have chosen to construct the ROM bases of both problems independently. Of special relevance is the ROM for the fluid, which is stabilized using a scheme inspired in the Variational Mulsticale (VMS) framework considering the unresolved scales orthogonal to the ROM basis. We present the algorithm that solves the coupled ROM-FSI problem and discuss its implementation aspects. This algorithm falls within the class of monolithic schemes solved using a block-iterative coupling.