Coupling schemes for the 3D FSI Benchmark Challenge: comparative study and validation

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ABSTRACT

A numerical study is presented (see [1]) in which several solution procedures for incompressible fluid-structure interaction (FSI) are compared and validated against the results of an experimental FSI benchmark (see [2, 3]). The mathematical models couple the incompressible Navier-Stokes equations (in ALE formalism) with the elastodynamics equations (both 3D and shell solid models are considered). Body fitted meshes with finite elements are adopted for the discretization in space. As regards the time discretization, we consider an archetypal sample of state-of-the-art numerical methods for FSI covering the three main families of coupling schemes: strongly coupled, semi-implicit and loosely coupled. All the solution procedures discussed are partitioned and, from the coupling algorithm standpoint, parameter free. Very good agreement is observed between the numerical results and the experimental data. The comparisons indicate that strong coupling can be efficiently avoided, via semi-implicit and loosely coupled schemes, without compromising stability and accuracy.

REFERENCES

[1] M. Landajuela, M. Vidrascu, D. Chapelle and M.A. Fernández. Coupling schemes for the FSI forward prediction challenge: comparative study and validation. *Int. J. Numer. Meth. Biomed. Engng.*, (2016); DOI: 10.1002/cnm.2813.

[2] N.R. Gaddum, O. Holub, A. Hessenthaler, R. Sinkus and D.A. Nordsletten. Benchmark experiment for validation of fluid-structure interaction algorithms. 4th International Conference on Computational & Mathematical Biomedical Engineering (CMBE15), Cachan (France), 2015.

[3] A. Hessenthaler, N.R. Gaddum, O. Holub, R. Sinkus, O. Röhre and D.A. Nordsletten. Experiment for validation of fluid-structure interaction models and algorithms. *Int. J. Numer. Meth. Biomed. Engng.*, (2016); DOI: 10.1002/cnm.2848.