6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

AN EXPLICIT LAGRANGIAN APPROACH FOR 3D SIMULATION OF FLUID-STRUCTURE-INTERACTION PROBLEMS

S. Meduri[1], M. Cremonesi[1] U. Perego[1]

[1] Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy.
massimiliano.cremonesi@polimi.it

Keywords: *FSI, PFEM-FEM Coupling, Explicit Solver, Lagrangian Formulation.*

In the present work we propose an efficient smoothing technique for mesh regularization for the simulation of three-dimensional fluid-structure interaction (FSI) problems. The fluid domain is modeled through an explicit version of the Particle Finite Element Method (PFEM) [1] under the hypothesis of weakly compressible flows. The structural part is modeled through the commercial software Abaqus/Explicit, which allows to exploit advanced features, such as wide library of constitutive laws and finite element and the capability to model contact interactions and large deformations.
The Gravouil and Combescure (GC) algorithm [2] is employed for the strong coupling between the two domains obtaining a fully explicit solution scheme allowing for the use of different time step sizes in each subdomain, a necessary features for an explicit method involving different materials. Furthermore, the fully Lagrangian nature of the coupled PFEM-FEM approach makes this method particularly suitable for applications with free-surface fluid flows and large displacements of the solid domain [3].
Frequent remeshing is a key feature of the PFEM. However, in 3D problems fast mesh generation algorithms introduce bad quality tetrahedra, leading to a vanishing time step increments in an explicit framework. A novel efficient technique has been developed to regularize the mesh and obtain time step sizes that are orders of magnitude larger than the ones obtained by simple Delaunay triangulation. The proposed algorithm is based on an elastic analogy that allows to exploit the same fully explicit architecture of the fluid solver, resulting in an efficient explicit and easy parallelizable smoothing procedure.
The comparison with analytical, experimental and numerical results presented in the literature shows the effectiveness of the proposed coupling method.

REFERENCES

[1] E. Oñate and S. Idelsohn, The particle finite element method: an overview. *Int. J. Comput. Meth.*, Vol. **2**, pp. 267–307, 2004.

[2] A. Gravouil and A. Combescure, Multi-time-step explicit-implicit method for non-linear structural dynamics. *Int. J. Num. Meth. Engng.*, Vol. **50**, pp. 199–225, 2001.

[3] S. Meduri *et al.*, A partitioned fully explicit Lagrangian finite element method for highly nonlinear fluid-structure interaction problems. *Int. J. Num. Meth. Engng.*, Vol. **113**, pp. 43–64, 2018.