14th World Congress on Computational Mechanics (WCCM)
ECCOMAS Congress 2020
19–24 July 2020, Paris, France

3D INTERACTION BETWEEN LAGRANGIAN FLUIDS AND HIGHLY DEFORMABLE STRUCTURES

Massimiliano Cremonesi[1], Simone Meduri[2] and Umberto Perego[3]

[1] Politecnico di Milano, p.zza Leonardo da Vinci 32 Milano Italy, massimiliano.cremonesi@polimi.it
[2] Phononic Vibes, Milano, Italy, simone.meduri@polimi.it
[3] Politecnico di Milano, p.zza Leonardo da Vinci 32 Milano Italy, umberto.perego@polimi.it

Key Words: Lagrangian approach, explicit coupling, PFEM

In the present work, an explicit partitioned approach is proposed for the solution of fluid-structure interaction (FSI) problems. An explicit version of the Particle Finite Element Method (PFEM) [1] is used to treat the fluid problem, while a standard explicit dynamics finite element approach is used for the solid part. Thanks to its Lagrangian nature, the PFEM can efficiently deal with free surface flows and large displacements of the fluid-solid interface (see e.g. [1, 2]). A fast remeshing algorithm, typically used to overcome the possible large distortion of the fluid mesh, has been coupled with a novel efficient runtime mesh smoothing technique intended to guarantee a regular fluid mesh with a reasonably large stable time increment. This smoothing algorithm is fully explicit and parallelizable, because it exploits the same architecture of the fluid solver thanks to an elastic analogy. SIMULIA Abaqus/Explicit has been used for the solution of the structural domain.

The two sub-problems have been coupled using a GC Domain Decomposition approach [3]. The fluid and solid domains are solved independently, as in the case of no interaction, and then they are linked at the interface using a Lagrange multiplier technique. Interesting features of the proposed method are: (i) the use of different time-steps in the two subdomains (ii) the possibility of non-conforming meshes at fluid-solid interfaces and (iii) a fully explicit solution scheme which guarantees a strong coupling [4].

The proposed approach has been validated with large scale 3D tests showing also possible applications to engineering problems with fast dynamics and a high degree of non-linearity.

REFERENCES

[1] Cremonesi, M., Meduri, S., Perego, U. and Frangi, A. An explicit Lagrangian finite element method for free-surface weakly compressible flows *Comp. Particle Mech.* (2017) **4**:357–369

[2] Oñate, E., Idelsohn, S.R., del Pin, F. and Aubry, R. The Particle Finite Element Method. An Overview. *Int J Computational Method* (2004) **1**:267–307

[3] Combescure, A. and Gravouil, A. A time-space multi-scale algorithm for transient structural non-linear problems *Mecanique et Industries* (2001) **2**:43–55

[4] Meduri, S., Cremonesi, M., Perego, U., Bettinotti O., Kurkchubasche, A. and Oancea, V. A partitioned fully explicit Lagrangian finite element method for highly nonlinear fluid-structure interaction problems *Int J Numer Meth Eng* (2018) **113**:43–64