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PFEM FOR MULTI-FLUIDS AND SOLID INTERACTION WITH FIXED MESH AND LARGE TIME-STEPS

P. Becker[1,*], S.R. Idelsohn[1,2] and E. Oñate[1,3]

[1]Centre Internacional de Metodes Numerics en Enginyeria (CIMNE) Campus Norte UPC,
08034 Barcelona, Spain
[2]ICREA Reseach Professor
[3] Universitat Politcnica de Catalunya (UPC)
* e-mail: *pbecker@cimne.upc.edu*

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Multi Fluids and Fluid-Structure Interaction (FSI) are important areas of active research where high effort is put into improving the accuracy of simulations and reducing the associated computational cost. In FSI, the usual approach to solve the problem is the partitioned strategy, which consists on solving separately the solid problem and the fluid flow and coupling them through interaction forces. While this strategy provides the simplification of treating each problem independently and therefore in a simpler way, it also leads to algorithms that demand several nonlinear iterations to ensure force balance between the phases.

Unfortunately, a direct naïve implementation of a unified approach would be computa- ve tionally demanding, due to the expensive system of equations that needs to be solved at each iteration. We propose an enhanced implementation of the Particle Finite Element Method(PFEM) for FSI [1] that takes advantage of the latest developments in the PFEM2 [2] to reduce solving time. The PFEM2 consists of using a fixed Finite Element mesh and a set of particles. These particles are mostly used to convect material properties following streamlines, while force computations are performed both on the mesh and at particle scale to improve accuracy. Our approach yields an enhanced version of PFEM2, capable of solving the fluid-solid interaction problem accurately while keeping low computation times.

The solver is validated against real-world lab tests showing good accuracy. Finally, the addition of a failure criteria to the solid phase expands the capabilities of the solver to simulate more complex phenomena. Preliminary results of debris flows simulations are presented, where the damaged material is converted from solid into a fluid flow.

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