Particle Finite Element Method (PFEM) for 2D/3D Fluid-Structure Interactions, including Contact Interactions

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Fluid-Structure Interaction (FSI) is a multiphysics coupling that aims to describe both fluid dynamics and structural mechanics. The present work is an extension of prior developments where a 2D PFEM solver has been developed and coupled with the solid solver Metafor using the Dirichlet-Neumann paradigm for simulating FSI problems involving fluid free surfaces, large deformations of solids and plasticity.

During this conference, we present the recent advances in FSI coupling by the introduction of a new in-house PFEM solver extended to 3D incompressible and weakly compressible flows, allowing the simulation of a larger range of complex problems. Notably, the presence of structural contacts within the fluid domain as well as frequent fluid detachments require a particular attention to be paid to the quality of the remeshing and the conservation of mass, which are two crucial elements governing the reliability and accuracy of the solution. In addition to further increasing the importance of the previous factors, the transition to 3D brings new challenges in terms of performance. Indeed, the computation time also becomes a critical element of the problem.

The presentation starts with a brief introduction to the basic principles of the PFEM and the Dirichlet-Neumann partitioned coupling, followed by a discussion about the remeshing procedure and the performances of the codes. Finally, this work will include, but will not be limited to, some examples and comparisons between 2D/3D FSI simulations such as the displacement and deformation of solid walls due an incident fluid flow, frictional contact of solids within the fluid domain or a flow-driven motion of debris in a pipe.