A new remeshing strategy relying on level-set functions for the particle finite element method

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ABSTRACT

Since the seminal work of Idelsohn, Oñate and del-Pin [1], the remeshing process of the Particle Finite Element Method (PFEM) has relied on a Delaunay triangulation (DT) followed by the Alpha–Shape (AS) algorithm. This DT+AS procedure guarantees a good quality of the Lagrangian mesh and allows modelling the merging and splitting of bodies, as in the simulation of free–surface flows. However, the remeshing procedure creates and removes elements during the merging or splitting of bodies, which modifies the mass of the system. In the literature, this issue has been addressed by mesh refinement strategies [2] or by adjusting the parameter ruling the AS algorithm [3].

The AS algorithm computes, for each element in the DT, a parameter that is representative of the size and distortion of the element, and compares it to a user–defined value. If the parameter is greater than the imposed threshold, then the element is removed from the DT. Differently, in this work we propose a new DT filtering criterion that resorts to a Level–Set (LS) function instead of the Alpha–Shape algorithm. The proposal maps the topology of the domain before the remeshing process using a LS function, where its sign indicates the inner or outer zone of the discretised body, while its magnitude gives an approximation of the distance to the body boundaries. The proposed criterion accepts the elements of the DT if they are inside the body, or very close to the body boundaries. Therefore, the criterion is information-enriched since it considers not only a geometrical aspect but also a topological feature.

The new meshing strategy proposed for PFEM is assessed using benchmark problems for the simulation of free–surface flows, fluid–structure interactions, and phase change, both in 2D and 3D. The results indicate that, at the expense of increased computational time, LS allows a substantial decrease in the mass variation during the remeshing process. In addition, it preserves the smoothness of the free surface and avoids numerical artifacts that are inherent to the AS-based procedure.

REFERENCES

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