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Senior Plenary Lecture

The Material Point Method and beyond

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Abstract

While the Finite Element Method (FEM) represents a recognized, well established and widely used technique in many engineeing fields, both in academia and industry, unfortunately it shows some limitation when dealing with problems where large deformation occurs. In the last decades many possible solutions and alternatives have been proposed and developed to overcome this drawback, among them one possibility is the use of the so called particle-based methods. Among them, we can find Lagrangian finite element techniques with remeshing, such as the Particle Finite Element Method (PFEM), or mesh-less techniques, such as the Smoothed Particle Hydrodynamics (SPH). Another alternative, presented in this talk, is the development of hybrid techniques, such as the Material Point Method (MPM), to blend the advantages of both mesh-based and mesh-less methods. MPM uses two different discretizations: a background mesh for calculation purposes (as in classical FEM) and a set of moving material points, acting as integration points, to store the hystorical information. MPM avoids the problems of mesh tangling while preserving the accuracy of Lagrangian FEM and it is especially suited for non linear problems in solid mechanics and fluid dymanics. The talk will show some recent advances in MPM formulations [1], presenting both an irreducible and mixed formulation stabilized using variational multiscale techniques, as well as the partitioned coupling strategies with other techinques such as FEM or DEM [2, 3].

References

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[3] SINGER, V., SAUTTER, K.B., LARESE, A., WÜCHNER, R. AND BLETZINGER, K.U., *A Partitioned Material Point Method and Discrete Element Method Coupling Scheme,* Under revision in Advanced Modeling and Simulation in Engineering Sciences (2022)