Towards a new dynamic fragmentation solver in Engineering

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ABSTRACT

Well-established computational techniques, such as the Finite Element, Finite Volume or Discontinuous Galerkin methods, rely on the tessellation of the domain of interest into a number of interconnected non-overlapping elements or control volumes (the so-called computational mesh). Despite their enormous success from the modelling standpoint, these mesh-based methods can suffer from mesh entanglement when simulating extreme deformation processes, such as dynamic fragmentation.

To circumvent this shortcoming, a wealth of alternative computational techniques, known as meshless or meshfree methods, emerged, where the domain is instead discretised into a set of moving particles which can interact within the region defined by a compact support [1]. One of the earliest meshfree methodologies is the Smooth Particle Hydrodynamics (SPH) method [2], which in its classical Updated Lagrangian (displacement-based) formulation, can exhibit one or more of the following drawbacks: tensile instability, lack of consistency, loss of conservation, long term instability and reduced order of convergence for derived variables such as stresses and strains.

To eliminate the above shortcomings, a new Total Lagrangian SPH computational framework [3] was recently proposed. Specifically, the linear momentum conservation equation is solved in conjunction with a series of geometric conservation laws for the minors of the deformation. Taking advantage of this new formalism, upwinding stabilisation is introduced avoiding the need for user-defined artificial stabilisation. The aim of the present work is the extension of [3] to an Updated Lagrangian description, where possible topological changes can be then handled through appropriate remapping techniques. Numerical examples are performed to assess differences between the two formulations and the work ends with a brief discussion on future lines of research.

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