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A new Jameson-Schmidt-Turkel Smooth Particle Hydrodynamics algorithm for large strain explicit fast dynamics

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Abstract

This paper presents a new Smooth Particle Hydrodynamics (SPH) computational framework for large strain explicit solid dynamics. A mixed-based set of Total Lagrangian conservation laws [1, 2] is presented in terms of the linear momentum and an extended set of geometric strain measures, comprised of the deformation gradient, its co-factor and the Jacobian. Taking advantage of this representation, the main aim of this paper is the adaptation of the very efficient Jameson-Schmidt-Turkel (JST) algorithm [3], extensively used in computational fluid dynamics, to a SPH based discretisation of the mixed-based set of conservation laws, with three key distinct novelties. First, a conservative JST-based SPH computational framework is presented with emphasis in nearly incompressible materials. Second, the suppression of numerical instabilities associated with the non-physical zero-energy modes is addressed through a well-established stabilisation procedure. Third, the use of a discrete angular momentum projection algorithm is presented in conjunction with a monolithic Total Variation Diminishing Runge-Kutta time integrator in order to guarantee the global conservation of angular momentum. For completeness, exact enforcement of essential boundary conditions is incorporated through the use of a Lagrange multiplier projection technique.

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