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A new Smooth Particle Hydrodynamics algorithm for large strain fast solid dynamics

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This presentation will describe a new computational paradigm [1, 2, 3] for the numerical simulation of large strain fast solid dynamics. Specifically, a new first order system of hyperbolic equations will be presented, expressed in terms of the linear momentum and the minors of the deformation (e.g. deformation gradient, co-factor and Jacobian). Taking advantage of this representation, in this presentation it will be shown how well-established stabilisation procedures (extensively used in computational fluid dynamics), can be adapted to a new Smooth Particle Hydrodynamics (SPH) algorithm, with three key novelties. First, a conservative and consistent SPH computational framework will be presented with emphasis on nearly incompressible materials. Second, SPH's inherent numerical deficiencies (e.g. tensile instability, spurious pressure, long term instability and/or convergence issues) will be addressed *ab initio*. Third, a discrete angular momentum projection algorithm will be used in conjunction with a monolithic TVD Runge-Kutta time integrator in order to guarantee the global conservation of angular momentum.

In the presentation, three conceptually different stabilisation procedures will be explored and compared, namely: (1) Jameson-Schmidt-Turkel stabilisation algorithm [3], (2) variationally consistent Streamline Upwind Petrov-Galerkin algorithm [2] and (3) Riemann-based upwinding stabilisation algorithm [1]. Finally, an extensive set of challenging numerical examples will be analysed. The new SPH algorithm will show excellent behaviour in compressible, nearly incompressible and truly incompressible scenarios, yielding second order of convergence for velocities, deviatoric and volumetric components of the stress.

REFERENCES

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