A method to improve SPH contact interfaces for solid body modeling

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Abstract

Smoothed Particle Hydrodynamics (SPH) has been used extensively to model solid bodies undergoing large deformation during hypervelocity impacts due to the ability of the method to handle distortion without the mesh entanglement issues posed by other Lagrangian discretizations such as the finite element method. Rather than using mesh connectivity, SPH uses a kernel function and performs smoothed integration over nearest neighbors to enforce the conservation laws of continuum dynamics. A number of improvements to the formulation have been proposed to increase stability and accuracy of the results for this type of application.

However, the mechanisms that facilitate interaction between separate bodies and enforcement of the resulting contact loads pose difficulties for SPH models. This is due in part to the fact that boundaries are not well defined by particle representation. External loading is applied in the form of particle contact and there is no distinction between particles located on the surface and those that make up the interior. Additionally, smooth demarcation of relatively simple curved surfaces is not possible without non-uniform particle spacing, a condition which invalidates the assumption that the Lagrangian mass values assigned to the particles can be uniformly distributed.

The work presented herein demonstrates the use of a new numerical process by which SPH bodies can be generated with well defined, accurate boundaries and appropriate corresponding mass distributions. Supplementary surface information for these bodies is retained throughout the analysis, augmenting any variant of the SPH formulation by providing a means of better enforcing boundary conditions.

Keywords: SPH, contact, numerical method, boundary conditions, high rate deformation, hypervelocity, large distortion, solid mechanics