A stabilization method for smoothed particle hydrodynamics preventing tensile instability and zero-energy modes

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Abstract

Smoothed particle hydrodynamics (SPH) is conventionally described in spatial coordinates hence employs Eulerian kernels which are updated each time step. That is proved to be the source of the tensile instability. Furthermore, SPH like other rank deficient methods such as reduced integration finite element method (FEM) and nodally integrated meshfree methods suffers from zero-energy modes. Ganzenmueller 2015 [1] and Ganzenmueller et al. 2016 [2] proposed an hourglass control scheme in analogy to FEM and showed it can effectively prevent tensile instability and zero-energy modes when it is applied to SPH described in material coordinates. Here, we introduce the hourglass control scheme which makes use of Lagrangian kernels to conventional SPH. The advantage of the method is that it only needs a few changes to incorporate the scheme into an already implemented SPH code. Several 2d and 3d simulations are carried out with and without the hourglass control scheme. The results prove the ability of the method to prevent both instabilities. Besides, the comparison between SPH results and FEM ones shows a good agreement between two methods.

Keywords: **Smoothed particle hydrodynamics, Stabilization, Tensile instability, Zero-energy modes and Hourglass control**

References

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