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Strong stability preserving explicit Runge-Kutta methods for SPH elastodynamics

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Developing an explicit time stepping scheme to accurately capture the dynamics in elastic materials is still a challenging problem. In the current study we investigate the accuracy and the stability of a family of explicit Runge-Kutta methods for the smoothed particle hydrodynamics (SPH) solution of equations in elastodynamics. The SPH method employs a purely meshless Lagrangian numerical technique for spatial discretization of the domain and it avoids many numerical difficulties related to re-meshing in mesh-based methods such as the finite element methods. The examined integration methods include the explicit Euler, explicit Runge-Kutta and explicit Runge-Kutta Chebyshev (RKC) schemes. Numerical results are presented for three test examples: shock-wave propagation in a one-dimensional problem, large deformation in a two-dimensional oscillatory beam, and the load-induced deformation of a two-dimensional elastic plate. It is found that the proposed RKC scheme offers a robust and accurate approach for solving elastodynamics using SPH techniques.

Keywords: Elastodynamics, SPH method, explicit Runge-Kutta schemes, Numerical simulations