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GPU-ACCELERATED COMPUTATIONAL TOOL DEVELOPMENT FOR STUDYING THE EFFECTIVENESS OF NUCLEAR SUBSURFACE EXPLOSIONS

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ABSTRACT

This paper is concerned with the development of a new GPU-accelerated computational tool for studying the effectiveness of a hypervelocity kinetic impact and a subsequent nuclear subsurface explosion. Accurate prediction of energy coupling with the target asteroid body is extremely important for asteroid fragmentation, as incorrect results could produce non-ideal fragmentation of the asteroid. The smoothed particle hydrodynamics (SPH) approach has been used for our previous studies. The SPH-based hydrocodes offer a simplistic framework, which makes implementation of the method straightforward. However, previous results of using SPH solvers have yielded some erratic results. Additionally, fragmentation of target bodies using the SPH-based hydrocodes is not intuitive, as large portions of mass can become “stringy” throughout simulations, resulting in inaccurate values for the predicted mass of each fragment. In this paper, we propose a new approach by employing high-order numerical methods and graphics processing units (GPUs).
High-order methods have a computationally efficient framework, well suited for the GPU architecture, allowing simulations to be completed orders of magnitude faster than the central processing unit (CPU) counterpart. A benchmark test problem is examined. To effect a nuclear detonation, the two-dimensional Euler equations are solved, where a small region is initialized with the energy equivalent to a nuclear explosion. The energy from the high-energy explosive device is monitored and coupled into a target body.