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Hybrid Computing in Large-Scale Multiphysics Simulation: Tabulated Properties and Particle-Cell Interpolations

Abstract

This work is directed toward addressing two computationally expensive segments in multiphysics reacting flow simulations. The first segment is the gas phase simulation including solving the gas dynamics equations coupled with a model to describe the reaction. In this work, these are described by pre-computed tabulated data, and it is shown that executing the tabulated functions across different dimensionality and interpolant order on the GPU instead of the CPU platform decreases the computational cost significantly. The second bottleneck is the interactions of the gas and the particle phase that are governed by Eulerian and Lagrangian formulations, respectively. These interactions, consisting of particle-cell interpolations, can take up to 20% of the simulation time. Regarding the number of particles and gas mesh size, performing particle-cell interpolation calculations on the GPU instead of the CPU can achieve up to 50x speedup.