The Smoothed Particle Hydrodynamics on modern architectures

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Numerical simulations of large-scale disasters, e.g., tsunamis, are important because such phenomena are difficult to carry out laboratory experiments.
Amongst several candidates for the numerical method, a particle-based numerical simulation method which is named Smoothed Particle Hydrodynamics (SPH) method is one of the most attractive methods.
In SPH, fluid is represented as a collection of hypothetical particles and governing equations for the fluid are converted into a sum of interactions between surrounding particles, which means that one SPH particle must interact with multiple numbers of particles.
This results in a large amount of memory access.

Note that architectures on which numerical simulations are performed are characterized by their B/F value, which is the ratio between the bandwidth and FLOPs.
For example, the B/F value for the post-K computer would be 0.5 and that for recent NVIDIA's GPUs is 0.1.
Note that the low-B/F value means that memory transfer limits the calculation speed.
Since SPH requires intensive memory access, a straightforward implementation of SPH on low-B/F architectures would result in low efficiency.
Hence, in order to effectively use such modern architectures, we need techniques to reduce the number of memory access in SPH.

In this work, we aimed at implementing an effective method to apply low B/F architectures to SPH.
We implemented the so-called ``multi-walk'' method to SPH.
The multi-walk method a method for particle-based methods to effectively use low B/F architectures.
We will report the predicted efficiency of our implementation on modern architectures, such as the K computer and NVIDIA GPUs.

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