CaKernel - A GPGPU Kernel Asbtraction and Implementation for Scientific Computing on Heterogeneous Systems

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Abstract

We presented our work to design and implement a GPGPU kernel abstraction, which is suitable for developing highly efficient large scale scientific applications using stencil computations on hybrid CPU/GPU systems. By leveraging the MPI-based data parallelism implemented in Cactus, we have developed a CaKernel programming framework in the CUDA/OpenCL architecture to facilitate the development process by automatically generating the highly optimized CUDA/OpenCL code of all declared kernel functions from a kernel descriptor, a set of computation templates, and a code generator. This kernel abstraction implementation has been tested and benchmarked with a 3D CFD implementation based on a finite difference discretization of Navier-Stokes equations. Our current effort is focused on minimizing the costs of the data exchange between GPU and CPU and optimizing the boundary exchange. Further integration in this area may improve performance and scalability.