The Discontinuous Galerkin Method on Heterogeneous Acrhitectures

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The discontinuous Galerkin (DG) method is a highly adaptable method which can be used to solve systems of hyperbolic conservation laws in complex geometries[1]. While the DG method has various useful properties, it is also computationally intensive and difficult to implement. To deal with the computational complexity, we have used the `OpenCL` programming environment, allowing us to run on `CPU`s, `GPU`s, and `MIC`s; one can implement an algorithm in an `OpenCL` kernel which is compiled at run-time for each device on which the algorithm is to be run. Moreover, one can make use of, for example, the `CPU` and `CPU` in parallel. However, memory management and load balancing can quickly become cumbersome, requiring much tedious programming work. We make use of the `StarPU`[3] runtime environment to deal with these issues. Here we present the `schnaps`[2] DG implementation, where the spatial domain is divided into macrocells of constant curvature which are represented as individual contiguous arrays in the computer's memory. By maintaining a constant curvature in each macrocell, we simplify the geometrical terms in the flux computation, and by separating the macrocell memory buffers, we have a natural parallelism between macrocells which can in principle be used by `StarPU` to divide the work between compute devices.

Références

[1] G. Cohen, X. Ferrieres, and S. Pernet, *A spatial high-order hexahedral discontinuous galerkin method to solve maxwells equations in time domain*, J. Comput. Phys., 217(2):340363, 2006.

[2] `schnaps.gforge.inria.fr`

[3] `starpu.gforge.inria.fr`

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