Lattice Boltzmann simulations using Multiple GPUs and application to fluid-structure interaction

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A very efficient implementation of a Lattice Boltzmann (LB) kernel in three dimensions on a graphical processing unit (GPU) using the Compute Unified Device Architecture (CUDA) interface developed by nVIDIA is presented. A special memory layout for the D3Q13 model is developed. The propagation and collision process are combined in one step and a special design for a very fast data access is developed. Methods for the parallelization of the code for multiple GPUs within one PC are developed. The data is exchanged over the host (CPU) memory via the PCI-Express bus. A good parallel efficiency for three GPU cards is obtained. With this approach over one billion lattices updates per second are reached. As an example we compute solutions for the drag of a moving sphere in a circular pipe for Reynolds-numbers ranging from 1 up to 500 and with an LES model from 1000 to 10000. We developed methods and algorithms to integrate the GPU computing and fluid-structure interaction and present preliminary results.