DESIGN AND IMPLEMENTATION OF A SCALABLE PARALLEL MULTI GPU / MULTI CPU LATTICE BOLTZMANN SOLVER

The lattice Boltzmann method (LB) is a modern and highly successful approach to computational fluid dynamics. Instead of directly solving the macroscopic equations (e.g. Navier-Stokes) a system of discrete kinetic equations is used which is designed to reproduce the target equations. The main advantage of this method is its computational efficiency and simplicity which leads to speed-ups of order of magnitudes compared to classical CFD approaches.

The LB method is particularly well suited for parallel architectures. However, heterogeneous systems, such as multi GPU / multi CPU clusters, pose additional requirements and add to the complexity of program design and implementation.

In this project a design for a generic 3D solver is to be developed bearing in mind performance, usability, generality and implementation aspects. A proof of concept implementation will be used to assess performance and scalability characteristics as well as the correctness of the solver.

**Tasks/Goals**

- get to know the LB method (write 2D code from scratch)
- literature survey of state of the art parallel LB solvers
- familiarize with 3D in house codes
- gather general requirements and constraints
- propose program design
- implement proof of concept application
- test and benchmark your solver

**Requirements**

- strong background in C++ (generic programming, templates, Boost)
- familiar with parallel communication (e.g. MPI)
- experience with OpenCL (or Cuda) is favourable
- familiar with software design patterns
- systematic and independent way of working

**Benefits**

- learn LB method
- design large-scale application from scratch
- gain knowledge in heterogeneous programming
- write and run code at large clusters: $O(10^3)$ CPU’s, $O(10^2)$ GPU’s

**Thesis Type and Duration**

Master thesis

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