MULTI-RELAXATION-TIME LATTICE BOLTZMANN SIMULATIONS ON MULTI-GPU CLUSTER

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The lattice Boltzmann method (LBM) as an explicit numerical scheme, which requires only neighboring operations, is very suitable for parallel or GPU computations. Thus, GPU has been successfully used for lattice Bolztmann computations [1, 2], which had demonstrated that the computational power of GPUs is far exceeded that of PC-based CPUs. In the present study, multi-relaxation-time (MRT) lattice Bolztamnn method [3] is used to compute three dimensional lid driven cavity flows. The present GPU implementation is an extension of the work by Chang et al. [2], where mainly the GPU global memory was adopted and the multi-GPU calculation was conducted on three GPUs within a single node with OpenMP. Here, message passing interface (MPI) based multi-GPU computations combined with shared memory are explored to increase the parallel performance. In this work, the following issues are addressed: (1) Performance of GPU using global memory and shared memory; (2) Factors affecting the scalability for cross-platform multi-GPU computations. The results obtained for three dimensional lid driven cavity flows are used to assess the performance of the computations.

REFERENCES

[1] J. Tölke, "Implementation of a lattice Boltzmann kernel using the compute unified device architecture developed by nVIDIA," Comput. Vis. Sci. **13**, 29, (2010).

[2] H. W. Chang, P. Y. Hong, L. S. Lin and C. A. Lin, "Simulations of flow instability in three dimensional deep cavities with multi relaxation time lattice Boltzmann method on graphic processing units," Comput. Fluids., **88**, 866, (2013).

[3] P. Lallemand, and L. S. Luo, "Theory of the lattice Boltzmann method: dispersion, dissipation, isotropy, Galilean invariance, and stability," Phys. Rev. E **61**, 6546, (2000).