**Parallelization of Lattice Boltzmann model in Thermohydrodynamics Problems and Simulating Natural Convection in Cavity**

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Lattice Boltzmann is a relatively new method in Computational fluid dynamics (CFD), which is based on mesoscopic kinetic equations. It is an approach that bridges microscopic phenomena with continuum macroscopic equations and with some special discretization has second order of accuracy in time and space. Macroscopic behaviors of system are computed with respect to kinetic equation and distribution functions. This method is particularly successful in fluid flow applications involving complex geometries, aerodynamics and reactive flows. Lattice Boltzmann thermo hydrodynamics use external forces terms in Boltzmann equation and a further equation beside Boltzmann equation that governs the convection and diffusion of heat [1]. This equation has its own distribution functions that we call it internal energy density distribution function. Generally discrete velocity set for second equation is not same as Boltzmann equation and viscous and compressive heating effect could be neglected [2]. Lattice Boltzmann generally need only nearest neighbors information and the algorithm is an ideal candidate for parallel systems [3]. Our code is implemented in C with MPI (Message Passing Interface) libraries for portability and is a SPMD (Single Program Multiple Data) model with 9 processing unit. Domain is divided into blocks and although the non-parallelizable part of the computation accounts for between 0.7 to 3 percent of the total computational load, we have tried to reduce communication time between these blocks. These are done by choosing different geometries of sub domains and change the directions of them; also it is tried to balance the loads on processors. Our test case is natural convection problem in a cavity and the results have been compared with its parallel mode. Speedup of system is excellent up to 1024*1024 grid (linear speedup) and shows good efficiency of method in simulating thermal problems in parallel mode. For communication part of our work, with reducing number of Calling send and receive function and increasing message length we have better communication times.

References:

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