Generalized form of Interpolation Supplemented Lattice Boltzmann Method with Local Time Steppping Technique

Taro Imamura, JAXA, imamura@chofu.jaxa.jp
Kojiro Suzuki, University of Tokyo, suzuki@sonic.t.u-tokyo.ac.jp
Takashi Nakamura, JAXA, nakamura@chofu.jaxa.jp
Masahiro Yoshida, JAXA, yoshida@chofu.jaxa.jp

There are requirements in obtaining steady-state-solution for incompressible flow simulations. Particularly in aerospace problems, drag prediction is a fundamental issue and drag is often calculated from the steady-state-solution.

In this paper, the local time step method is applied to the Lattice Boltzmann Method (LBM) on non-uniform grid (Generalized form of Interpolation supplemented LBM:GILBM)[1,2]. The local time step method is known to be an effective technique to accelerate the solution to the converged steady-state on non-uniform grid. The local time step method means that each grid point uses a time step, which is based on the local advection term stability condition. The convergence to the steady state flow is expected to be accelerated, since larger time step can be used for larger grid cell.

Two-dimensional flow simulations around an airfoil were performed in order to validate the present code and the results are compared with the global time step solutions. The pressure distribution and the aerodynamic coefficients of global and local time step results are in good agreement. They are also consistent with the previous studies. At the same time, CPU time required to obtain the steady-state solutions using the local time step are reduced by 70% to 80% compared with that using global time step.

Reference

[1] Xiaoyi He, Li-Shi Luo, and Micah Dembo, “Some Progress in Lattice Boltzmann Method. Part 1. Nonuniform Mesh Grids”, *J. Comput. Phys.* **129**, 357 (1996)
[2]X.He, and G.Doolen, “Lattice Boltzmann Method on Curvilinear Coordinate System: Flow around a Circular Cylinder”, *J. Comput. Phys.* **134**, 306 (1997)