Easy Implementation of Nested Grid Refinement on Lattice Boltzmann Method for Numerical Speed Up Purpose

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Abstract:

Lattice Boltzmann method (LBM) is a computational fluid dynamics (CFD) method that shines on uniform cartesian grid even when used for complex geometry. However, keeping the uniformity is a loss potential, especially in an external flow case which needs a large domain size relative to geometry. In that case, up to 80% of grid nodes do not need high resolution because they only contain low gradient solutions. To optimize computational performance, a non-uniform grid scheme is needed. One way to do this is by using a grid refinement method proposed by Rohde. In this paper, Rohde's refinement method will be implemented with simplicity in mind to produce a nested grid refinement algorithm. The algorithm is tested to flow over cylinder of various Re from 10-400 in 2, 3, 4, and 5 levels of nested grid refinement. The results of all cases are almost perfect, visually and parametrically, compared to no-refinement case. The speed-up gained is up to 23 times compared to no-refinement case.

Keywords:

Grid refinement, lattice Boltzmann method, multiresolution, computational performance.