Navier-Stokes equations for image processing using the LBM method

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Abstract:

As a mesoscopic method based on the kinetic Boltzmann equation, the lattice Boltzmann method (LBM) has been developed rapidly in the last three decades. As an alternative scheme of solving the Navier-Stokes equations, the LBM is usually designed as a fully discretized version of the Boltzmann equation with a set of symmetric discrete velocities to ensure isotropy in the kinetic theory. In the LBM, only a few discrete, kinetic-particle velocities are used, and the kinetic velocities are fully coupled to the lattice grid in the physical space and the time step size, which makes the numerical implementation highly efficient when compared to other kinetic schemes. Through multiscaling expansion [7], the incompressible Navier-Stokes equations can be recovered from the lattice Boltzmann BGK equation [4]. The advantage of the lattice Boltzmann method is that it provides easily implemented fully parallel algorithms and the capability of handling complicated boundaries. In this work, we propose a new approach to fluid image registration problem [6] by using LBM method, and the partial differential equation (PDE) that we used to solve this problem is the incompressible Navier-Stokes equation.

Key word: Image registration; Navier-Stokes equations; Lattice Boltzmann Method; Chapman-Enskog analysis.

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