Application of the lattice Boltzmann method in acoustics

Erik M. Salomons*, Walter J.A. Lohman, and Han Zhou

TNO Netherlands Organization of Applied Scientific Research
Van Mourik Broekmanweg 6, 2628 XE Delft, The Netherlands
e-mail: erik.salomons@tno.nl

ABSTRACT

In this paper, practical aspects of the lattice Boltzmann method for fluid flow are explored and application to sound propagation is investigated. This work was performed within the framework of the European ITEA project MACH, which aims at optimizing scientific calculations on various parallel platforms. For fluid flow, our attention was drawn to the lattice Boltzmann method because of its advantages over other methods: the method is suitable for parallel computation, and it can be applied easily to systems with complex boundaries, such as porous media.

We first developed simple 2D and 3D lattice Boltzmann codes for fluid flow in a lid-driven cavity. We explored possibilities to run it on the GPU of a personal computer, and we investigated GPU speed-up factors.

Next we developed a lattice Boltzmann code for simulation of sound waves. Various acoustic phenomena were investigated with this code, such as geometrical spreading of sound waves generated by a point source, reflection of sound waves by a rigid surface, and diffraction of sound waves by a noise barrier. Reflection of sound waves by a porous medium was also explored, and a comparison was made with theoretical solutions. Finally, the possibility to simulate sound propagation in an atmosphere with wind and temperature gradients was considered.