Aerodynamisches Institut und Lehrstuhl für Strömungslehre | RWTH AACHEN UNIVERSITY

Master thesis

Flow simulation of moving rigid bodies using the lattice Boltzmann method on GPU

Air traffic, which is a major cause of environmental noise, is expected to steadily increase in the near future. Urban air mobility (UAM) is expected to cause additional annoyance in urban regions if not regulated properly. Therefore, investigation of noise generation mechanism and noise reduction technologies is of growing interest in research and industry. Distributed propulsion technologies, which are popular in current UAM concepts, involve challenging flow scenario like rotor-wing interactions, see fig. 1.

The lattice Boltzmann method features good parallelization properties as well as low dissipation and dispersion errors making it suitable for computing the turbulent flow as well as the acoustic far field at once.
In the case of a rotor-wing configuration there is no frame of reference in which neither the wing nor the rotor do not move relatively. Hence, additional challenges arise from treating the boundary condition of the solid surface traveling across the computational grid, e.g., determining the intersection of the surface with grid cells in an efficient parallelizable manner.

Within this thesis, the existing methods for intersection calculations, mainly being based on line-triangle intersection, are first ported to run on GPU using parallel algorithm introduced in C++17. Subsequently, rigid body movement is added, whereas building up on an established approach working with a level-set representation of the solid interface is a helpful orientation. Finally, a validation as well as a performance comparison with the established method is to be discussed for an aeroacoustic application.

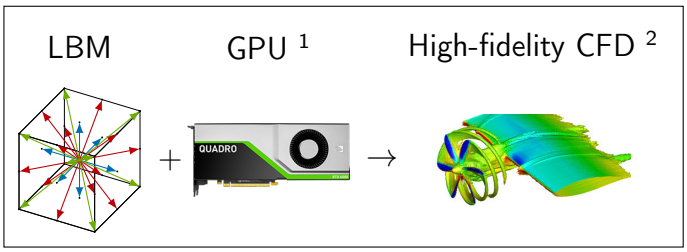

Fig. 1: Objective of this thesis is to develop efficient wall intersection routines for moving surfaces on GPU. .

Research aspects

- Learn the fundamentals of the LBM
- Develop knowledge on GPU programming
- Extend in-house solver's functionalities
- Large-scale simulations

You ...

- ... are searching for an interesting thesis in the field of computational fluid dynamics
- ... have advanced programming experience (preferably C++)
- ... are eager to learn new skills and are able to work in an independent manner

If you are interested, please contact incl. CV and transcript of records:

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[2] P. Aref et al., Aerospace. 2018; 5(3):79. https://doi.org/10.3390/aerospace5030079