Towards large-scale parallel GPU-accelerated SPH for FSI problems

Michael Gestrich*,††, Stefan Adami††, Takayuki Aoki† and Thomas Indinger††

*,† Global Scientific Information and Computing Center (GSIC)
Tokyo Institute of Technology (TiTech)
2-12-1 O-okayama, Meguro-ku, Tokyo 152-8550, Japan
e-mail: mgestrich@sim.gsic.titech.ac.jp, web page: http://sim.gsic.titech.ac.jp

†† Chair of Aerodynamics and Fluid Mechanics (AER)
Technische Universität München (TUM)
Boltzmannstr. 15, 85748 Garching, Germany
e-mail: aerodynamik@tum.de, web page: http://www.aer.mw.tum.de

ABSTRACT

A method to simulate the water removal from the windscreen of cars by windscreen wipers using Smoothed Particle Hydrodynamics on parallel GPU platforms is being developed based on the nanoFluidX code.

A fluid modeling approach based on Hu & Adams [1] is applied with a density summation approach with free surface treatment. Currently large-scale fluid simulations are performed on more than two hundred GPUs on the TSUBAME supercomputer operated by the Global Scientific Information and Computing Center (GSIC) at Tokyo Institute of Technology. Dynamic load-balancing is performed using the Zoltan library providing a Recursive Coordinate Bisection decomposition method (see Boman et al. [2]). An overlapping communication procedure is applied using CUDA streams.

The current research focus is to extend to Fluid-Structure Interaction problems as a first step to be able to simulate the deformation of the rubber lip of the wiper when interacting with the water film. For elastic solid modeling, the generalized transport-velocity formulation by Zhang et al. [3] is adapted. A coupling based on the wall boundary condition as proposed by Adami et al. [4] is applied. Preliminary results of Fluid-Structure Interaction benchmarks such as a dambreak with an elastic opening gate (see Antoci et al. [5]) are shown to demonstrate the applicability. Work to adapt to 3D Fluid-Structure Interaction problems in parallel is currently in progress.

REFERENCES

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