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cuIBM: a GPU-based immersed boundary method code

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Summary

cuIBM solves the two-dimensional Navier-Stokes equations with an immersed-boundary method on structured Cartesian grids. With this solution approach, we remove the constraint for the computational grid to fit to the surface of a body immersed in a fluid. This has the advantage of requiring simple and easy-to-generate fixed Cartesian grids. cuIBM can be used to simulate the flow around fixed or moving bodies without the need to regenerate grids. Example applications may include flapping airfoils for the study of animal flight or fish locomotion. The equations are spatially discretized with a finite-difference technique and temporally integrated via a projection approach seen as an approximate block-LU decomposition (Perot (1993)). cuIBM implements various immersed-boundary techniques that fit into the framework of Perot's projection method. Among them are the immersed-boundary projection approach from Taira and Colonius (2007), the direct-forcing method from Fadlun et al. (2000), and a second-order accurate direct-forcing method (Krishnan (2015)).

cuIBM is written in C++ and exploits NVIDIA GPU hardware using CUDA and CUSP, an open-source C++ library for sparse linear algebra on CUDA-capable GPUs. cuIBM solves the linear systems of equations and applies stencil operations on a single GPU device.

cuIBM generated the results published in Krishnan et al. (2014), a study of gliding-snake aerodynamics using an anatomically accurate cross-section of the snake *Chrysopelea Paradisi*.

References

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