High performance discontinuous Galerkin methods in aerodynamical shape optimization

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Recent studies have shown advantages of the application of streaming processors for highly arithmetic expensive problems arising from the simulation of physical models governed by partial differential equations. Especially when it comes to optimization an efficient evaluation of the PDE and its adjoint is crucial. This talk introduces a high-order discontinuous Galerkin (DG) implementation on graphics processing units (GPUs) for compressible Navier-Stokes and Euler equations with focus on its parallel performance. It is shown that the speedup, which can be gained by the application of GPUs, increases with the order of the discretization method. This is a desirable feature especially in the field of fluid dynamics where there is a great demand for fast algorithms with high spatial resolution. Moreover, GPU acceleration for the corresponding discrete adjoint is addressed and its application in aerodynamic shape optimization is presented. It is also discussed which challenges arise in optimization due to higher order discretizations of both the PDE and physical obstacles in the flow field. For that purpose a mesh deformation approach based on linear elasticity is introduced. Thus, in this presentation the entire toolchain from constructing curved, body-fitted meshes, over the simulation of fluid dynamics using HPC hardware, to the shape optimization of geometric entities is covered.

References

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