Coupling Flow and Acoustic Solvers with Two Different Coupling Approaches

Neda Ebrahimi Pour, Harald Klimach, Verena Krupp, Kannan Masilamani and Sabine Roller*

Simulation Techniques & Scientific Computing, Adolf-Reichwein-Straße 2, 57068 Siegen, Germany, {neda.epour, harald.klimach, verena.krupp, kannan.masilamani, sabine.roller}@uni-siegen.de

The reduction of noise is one of the challenging tasks in the field of engineering. The interaction between flow, structure, and an acoustic field (FSA) involves multiple scales. Due to these phenomena the physical effects on different scales have to be considered accordingly. Yet, their effect can be spatially separated into different domains which then need to interact at their coupling interfaces. In this work the partitioned coupling of relevant domains in direct aero-acoustic simulations are reviewed. We mainly consider the flow and the acoustic domains. We present how the two coupling approaches *preCICE* [2] and *APESmate* can be used, to couple different domains according to their computational requirements. The coupling approach *preCICE* is based on a black box coupling, where just the point values at the surface of the coupling domains are known. In contrast *APESmate* has knowledge about the numerical schemes within the domain. Thus, *preCICE* needs to interpolate values, while *APESmate* can evaluate the high order polynomials of the underlying Discontinous Galerkin scheme. Hence, the *preCICE* approach is more generally applicable, while the *APESmate* approach is more efficient, especially in the context of high order schemes. The coupling is performed with three different domains: a Navier-Stokes domain, an Euler domain and a linearized Euler domain. The Navier-Stokes domain is resolved with a low order scheme, but a high resolved mesh to capture all physics in the domain. For the Euler domain a higher order and a lower mesh resolution is considered, while for the linearized Euler an even higher order and a coarse mesh is used to resolve the acoustics. Overall, we demonstrate how the specifically tailored choice of numerical schemes can reduce the computational effort for the direct acoustic simulation when compared to a monolithic approach.

References

[1] S. Roller, J. Bernsdorf, H. Klimach, M. Hasert, D. Harlacher, M. Cakircali, S. Zimny, K. Masilamani, L. Didinger, and J. Zudrop. *An adaptable simulation framework based on a linearized octree*. In M. Resch, X. Wang, W. Bez, E. Focht, H. Kobayashi, and S. Roller, editors, High Performance Computing on Vector Systems 2011, pages 93105. Springer Berlin Heidelberg, 2012.

[2] H.-J. Bungartz, J. Benk, B. Gatzhammer, M. Mehl and T. Neckel, *Partitioned Simulation of Fluid-Structure Interaction on Cartesian Grids*. In H.-J.Bungartz, M. Mehl and M.Schäfer,editors,Fluid-Structure Interaction – Modelling, Simulation, Optimisation, Part II,pages 255-284,Springer Berlin,Heidelberg, 2010.