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Implementation of Hybrid CFD/CAA methods for the Prediction of Aeroacoustic Sound on HPC Systems

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The mitigation of aerdoynamically generated sound is of great interest in many technical application such as aircrafts, turbomachinery or ventilation systems. In many cases, the prediction of mixed tonal and broadband noise requires accurate and detailed information about the turbulence embedded in the flow field, which can only be obtained with turbulence scale resolving numerical methods such as large eddy simulation (LES). Due to the typically high Reynolds numbers the necessary mesh resolution and number of time steps, the application of such methods requires large HPC resources. For a direct coupled high-fidelity computational fluid dynamics (CFD)/computational aeroacoustics (CAA) method even more computational resources are required. This paper discusses the implementation of two hybrid CFD/CAA methods on HPC hardware. In more detail, a finite-volume or, alternatively, a lattice Boltzmann method used for the flow field prediction, directly coupled with a discontinuous Galerkin method for the determination of the acoustic wave generation and propagation will be presented. Both hybrid methods are formulated for hierarchical adaptively refined meshes [1]. Dynamic load balancing based on CPU timers is used to perform simulations efficiently on heterogeneous hardware [2, 3]. A programming model based on the parallel standard template library defined in the C++ standard 17 is used to support multithreading on CPU based hardware and execution on GPUs with the same code version. Applications are presented for the prediction of landing gear noise for which fairings are used for noise reduction. Details of the numerical method, programming model and applications results will be presented on the conference.

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