Leveraging GPU hardware for automotive acoustic design

Alessandra Verza, Liam McManus (Siemens Digital Industries Software)

Abstract

Electrification is rapidly becoming the focus of the automotive sector, with major manufacturers developing new models and smaller start-ups creating new designs. When it comes to electric vehicles, NVH (Noise Vibration and Harshness) takes a prominent role in vehicle refinement. Some component noises that were previously masked by the powertrain have now acquired an important part in overall cabin comfort [1]. Passenger comfort continues to be an increasingly important sales driver meaning that noise reduction must be considered early in the design process [2].

Turbulent flow produced by vehicles travelling at typical highway speeds generates forces on the body of the vehicle which must be accurately simulated by acoustic engineers. CFD simulations have therefore become increasingly important to help simulate the noise coming from components such as HVAC, fans and design features, minimizing the need for expensive wind tunnel tests.

Typically, high-fidelity modelling of the turbulent flow field is required for accurate noise predictions [3]. However, one of the main limiting factors of such simulation methodologies is the computational cost. Large computational meshes, coupled with small computational time steps result in long runtimes. Designers operating under a computational cost cap but still wishing to increase the design space explored therefore must choose between reducing the fidelity of their simulations or increasing computational resources. The use of GPUs allows for an opportunity to increase computational resources in a cost-effective manner.

GPUs have become increasingly important for general-purpose HPC in recent years due to their unique architecture and capabilities. GPUs are designed to efficiently perform massive parallel computations required by many scientific and engineering applications. With the growing demand for large-scale data processing and complex simulations, GPUs offer a cost-effective and energy-efficient solution. Additionally, the availability of high-level programming languages and libraries [4] that leverage GPUs' parallel computing power has made it easier for developers to harness their capabilities. As a result, GPUs have become a popular tool in scientific computing, machine learning, and other data-intensive fields.

This presentation will discuss how improved modeling techniques and GPU hardware can help reduce the design time for products which require minimal noise generation. The challenges and important considerations of high-fidelity modeling on GPU will also be discussed.

References

[1] Otto, N., Simpson, R., Wiederhold, J., 1999, "Electric Vehicle Sound Quality",1999-01-1694, SAE Technical Paper 1999-01-1694, SAE International

[2] M. Zaareer and A.-H. Mourad, “Effect of Vehicle Side Mirror Base Position on Aerodynamic Forces and Acoustics,” Alexandria Engineering Journal, vol. 61, no. 2, pp. 1437–1448, Feb. 2022.

[3] F. Menter, A. Hüppe, A. Matyushenko, and D. Kolmogorov, “An Overview of Hybrid RANS–LES Models Developed for Industrial CFD,” Applied Sciences, vol. 11, no. 6, p. 2459, Mar. 2021.

[4] “HPC SDK | NVIDIA,” NVIDIA Developer, Mar. 11, 2020. https://developer.nvidia.com/hpc-sdk