A performance portable implementation of SIMD vector intrinsics on high-order, entropy-stable spectral collocation schemes for compressible turbulent flow

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Abstract

High-fidelity simulations of compressible turbulent flows play a crucial role in the development of future technologies. Exascale computing will be a key component in enabling high-fidelity analysis and design but fundamental shifts in computing architectures have introduced challenges into how to best exploit modern hardware. High-order, matrix-free methods have the potential to dramatically improve the efficiency of these simulations by benefiting more from the high computational throughput on modern hardware compared to traditional second-order methods. Unfortunately, modern hardware is changing rapidly and refactoring a code to work efficiently on the latest hardware is becoming increasingly infeasible. In an effort to avoid architecture specific programming, software libraries such as Trilinos [1] and programming models such as Kokkos [2] are important to obtain performance portable implementations.

In this talk, we provide an overview of a performance portable implementation for high-order, entropy-stable spectral collocation schemes for tensor product elements through the use of Trilinos libraries and the Kokkos programming model. A portable implementation of SIMD vector intrinsics is introduced, tested and analyzed on the latest architectures. We also introduce a preconditioned Jacobian-free Newton-Krylov method to drive unsteady simulations of turbulent compressible flow and provide a performance analysis of the solver on both CPU and GPU architectures.

References

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