SAND2020-0459C

14th World Congress on Computational Mechanics (WCCM)
ECCOMAS Congress 2020
19–24 July 2020, Paris, France

HIERARCHICAL PARALLELISM FOR TRANSIENT SOLID MECHANICS SIMULATIONS

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Key Words: Finite Element Software, Solid Mechanics, Hierarchical Architectures.

Hierarchical parallelism plays an increasingly important role in scientific high-performance computing. The use of on-node accelerators, in particular GPUs, significantly reduces turnaround times. This performance improvement enables the application of existing techniques to very large computational domains, and improves the outlook for higher-fidelity approaches that have been considered intractable to date. In this presentation, we review an ongoing effort to utilize GPU accelerators in the *NimbleSM* finite element code for transient dynamic solid mechanics simulations. Focus areas include the constitutive model, the calculation of stress divergence, and the computation of contact forces. The *Kokkos* software package for performance portability is extensively utilized, providing a parallel-for mechanism and corresponding data structures that are configured at compile time for optimal performance on the target architecture. Here, memory management plays an important role due to differences in optimal access patterns across disparate architectures. An additional concern is the evolving nature of next-generation hardware, which is addressed by encapsulating hardware-specific source code such that it can be altered at a later date without the need for invasive changes to the computational kernels themselves. Our implementation strategy will be discussed, followed by performance analysis of explicit transient dynamics simulations. The ability to utilize increased on-node parallelism is shown to be an important component of next-generation engineering analysis codes.

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