AN EFFICIENT PARALLEL IMPLEMENTATION OF THE SPACETIME DISCONTINUOUS GALERKIN METHOD USING CHARM++[1]

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We present an efficient parallel implementation of the Spacetime Discontinuous Galerkin method for hyperbolic problems. In particular, we are interested in parallel implementations of direct element-by-element or patch-by-patch solution techniques that are possible on spacetime meshes that conform to an appropriate causality cone constraint [1]. We consider applications to linearized elastodynamics [2] as well as to nonlinear conservation laws. Our implementation is based on the Charm++ [3] Finite Element Method (FEM) framework [4].

The FEM framework provides automatic mesh partitioning. In addition, it updates boundary conditions and boundary element data across the partitioned mesh. The framework also provides access to many Charm++ features [5]; these include message-driven execution, automatic load balancing, shrink/expand capability and automatic checkpoint/restart. Accessing these features requires little to no effort by the application developer, as the code that enables them is part of the FEM framework itself.

The causality cone constraint introduces special challenges in the case of nonlinear conservation laws, where the constraint is solution-dependent. This requires us to interleave mesh generation with the solution process in a parallel, advancing-front algorithm. In contrast to linear problems where a local search suffices, implementation of the cone constraint in nonlinear problems requires a global search. We demonstrate a parallel library that implements the global check for the cone constraint, and present results that demonstrate its impact on performance. We present results obtained on large parallel machines and discuss directions for continuing research.

References

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