Efficient Evaluation of Space-Time Boundary Integral Operators on SIMD Architectures

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Abstract

The boundary element method (BEM) has become a well established tool for solving partial differential equations. An inseparable part of any BEM code is the evaluation of boundary integral operators including singular integrands. In the talk we present our approach to efficient implementation of the (semi-)analytic approach and of the regularized tensor Gauss quadrature scheme. Although OpenMP threading has become more or less standard in scientific codes, vectorization (now also included in OpenMP) is often neglected. We thus concentrate on the optimizations such as data alignment and padding, array-of-structures to structure-of-arrays transition or loop collapsing leading to optimal utilization of the available vector processing units.

The model problems used for the verification of the suggested approach include the steady-state heat (Laplace) equation as well as the evolutionary heat equation. For the latter, a time-stepping scheme is often used to treat the time and spatial derivatives separately. However, we employ a space-time boundary integral formulation leading to the discretization of the whole space-time boundary at once. Although this approach leads to large systems of linear equations, it naturally exposes more parallelism and is well suited for modern high performance computing infrastructures.

References

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