

AutoMT : Domain Specific Language and Matrix Tensor Library for Solid Mechanics

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ABSTRACT

Domain Specific Language (DSL) is one of the promising technologies for achieving both code performance and productivity in software development. It can also be used for developing a numerical simulation code. Currently, we are preparing a DSL called AutoMT, dedicated for the continuum mechanics field. The associated library for matrix and tensor operations is also provided.

First, AutoMT library handles tensor quantities in the three dimensional space, such as scalar, vector, 2nd order tensor and 4th order tensor. It can also support the corresponding matrix and vectors of very small size, such as 3x3 and 6x6. These tensor and matrix operations appear often in element-wise, cell-wise or particle-wise calculation in a continuum mechanics-based simulation code. Implementations of the library for various kinds of high performance computing platforms, such as x86 SSE/AVX/MIC, K Computer/Fujitsu PRIMEHPC FX-10 and GPUs, are available. Each of them is highly tuned for the underlying hardware architecture.

Then, a LaTeX-like DSL is built on top of the AutoMT matrix and tensor library. The language supports the concept of tensor and small-sized matrix directly as abstract types, which is often used in the context of solid and fluid mechanics. The syntax of the DSL is based of LaTeX, which is one of the major choices for writing engineering documents and mathematical formulas. The DSL translator converts from DSL source code into the corresponding C/Fortran source code, which is mainly composed of function/subroutine calls to the AutoMT library.