Autotuning by Changing Directives and Number of Threads in OpenMP using ppOpen-AT

Toma Sakurai
Graduate School of Informatics
Nagoya University
Japan
sakurai@hpc.itc.nagoya-u.ac.jp

Takahiro Katagiri
Information Technology Center
Nagoya University
Japan

Satoshi Ohshima
Information Technology Center
Nagoya University
Japan

Toru Nagai
Information Technology Center
Nagoya University
Japan

Recently, computers have diversified architectures. To achieve high numerical calculation software performance, it is necessary to tune the software according to the target computer architecture. However, code optimization for each environment is difficult unless it is performed by a specialist who knows computer architectures well. One of promising technologies to reduce the tuning effort is applying autotuning (AT). Optimized implementation by AT that enhances computer performance can be used even by non-experts.

In this research, we propose a technique for AT for programs using open multi-processing (OpenMP). We propose an AT method using an AT language that changes the OpenMP target loop and changing the number of threads in OpenMP on the fly according to computational kernels.

We assume ppOpen-AT [1] as the autotuning method. ppOpen-AT is an AT language developed as an AT mechanism for the next generation of science and technology application development. It provides an execution environment for ppOpen-HPC [2]. Designed to improve the developmental efficiency of parallel numerical computation libraries, it inherits the functions of the AT directive-based language ABCLibScript [3]. ppOpen-AT adds AT functions to Fortran90 and C programs. Because descriptions about AT are dedicated directives, the AT software can be efficiently developed compared to development in environments without ppOpen-AT. The ppOpen-AT preprocessor interprets directives and generates code for tuning candidates and programs that include an AT function that searches for the optimal code.

We propose an AT function for loop transformation that changes the target parallelization loop and dynamic change of the number of OpenMP threads. This can be implemented as a new function of ppOpen-AT. Our target is multiple nested loops being parallelized by OpenMP. We will implement a function to specify an OpenMP target loop by giving directives to ppOpen-AT. If these functions are implemented in ppOpen-AT, it will be easy to develop autotuning.

To explain the proposed method, we use the application software, Gyro Kinetic Vlasov (GKV) [4]. GKV is a program developed by T. Watanabe for use in the plasma simulation field.

Performance evaluation was performed using the Fujitsu PRIMEHPC FX100, which is a K-computer type supercomputer installed at the Information Technology Center, Nagoya University.

We evaluated the efficiency of the two AT functions. Results indicated that a maximum increase in execution speed of 1.801 times that of the original loop was obtained as compared to conventional execution, using AT functions in GKV as a benchmark. This indicates that proposed AT function can easily apply typical scientific simulation codes, such as plasma simulation.

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