The multigrid method with OpenMP/MPI hybrid parallel programming model is expected to play an important role in large-scale scientific computing on post-peta/exa-scale supercomputer systems. Multigrid is a scalable method for solving linear equations and for preconditioning Krylov iterative linear solvers, and it is especially suitable for large-scale problems. The concepts of OpenMP/MPI hybrid parallel programming models can be easily extended and applied to supercomputers based on heterogeneous computing nodes with accelerators/co-processors, such as GPUs and/or many-core processors by Intel Many Integrated Core Architecture.

It is well known that the multigrid method includes various choices of parameters. Because each of these strongly affects the accuracy, the robustness, and the performance of multigrid procedures, selection of the optimum combination of these is very critical. In OpenMP/MPI hybrid parallel programming models, the number of threads strongly affects the performance of both the computation and the communications in multigrid procedures [1].

In the present work, we focus on the selection of single-threading or multi-threading in procedures of parallel multigrid solvers using OpenMP/MPI hybrid parallel programming models. We propose a new method of automatic tuning (AT) of the parameters with a simple empirical method. The proposed method implemented in the code in [2] is evaluated by using up to 8,192 cores of the T2K/Tokyo, the Cray XE6, and the Fujitsu FX10. The proposed method for AT is effective, and the automatically tuned code provides twice the performance of the original one.
