Numerical Investigations of Variable Preconditioned GCR with Mixed Precision on GPU

S. Ikuno, N. Fujita, S. Deki

Tokyo University of Technology, Katakura 1404-1, Hachioji 192-0982, Japan

ikuno@nal.ikulab.org

Generally, it is necessary to solve a large simultaneous linear system in the numerical calculation of equilibrium configuration of Spheromak plasma or Tokamak plasma. Moreover, the speed and high accuracy is required for solving the system.
Recently, the performance of Graphics Processing Unit (GPU) surpass that of CPU and various researches of General Purpose for GPU (GPGPU) have been proposed aggressively. However, GPU can calculate in the case of single precision early, but becomes slow in double precision calculation because GPU is a device used for drawing of the graphics.
K. Abe *et al.* developed new preconditioning strategy which is called the Variable Preconditioned Generalized Conjugate Residual (VPGCR) method [1]. VPGCR has the advantageous character for GPU. The convergence theorem of VPGCR is guaranteed that the residual of VPGCR converges if the relative residual norm of variable precondition calculation r satisfies the criterion $r < 1$. That is to say, the residual equation can be solved in the range of single precision. Therefore, VPGCR with mixed precision that uses single precision operation for variable preconditioning calculation and double precision operation for GCR is adopted for the solver on GPU.
The values of speedup ratio are plotted in Fig. 1. The ratio is calculated as execution time of GPU versus that of CPU and various parameter γ of Toplitz matrix is adopted for coefficent matrix. This figure indicates that the calculation time of GPU is 33 times faster than that of CPU in case of $\gamma = 1.0$.

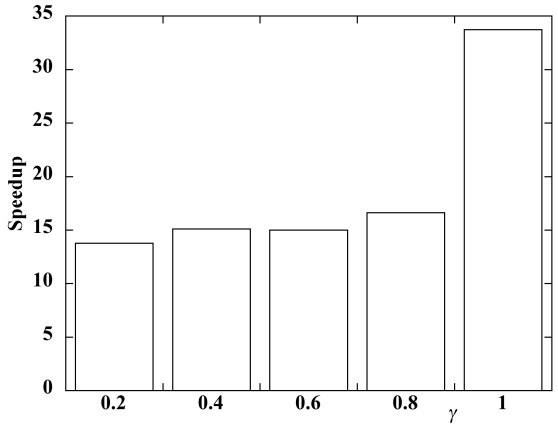

Figure 1: The values of speedup ratio are plotted as function of parameter γ.

[1] K. Abe, S. L. Zhang, Int. J. Numer. Anal. Model. **22** (2005) 147