High Performance Multi-CPU and Multi-GPU Computing of the High-Order FV24 Algorithm

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FV24, a three dimensional second-order in time and fourth-order in space finite difference time-domain(FDTD) algorithm, in this work, makes use of parallel computing schemes that allow it to run on multiple Graphical Processing Units (GPUs) and multiple CPU cores using OpenMP and CUDA Fortran. The increase in available memory and computational throughput using these schemes, when compared to a single-CPU or single-GPU code, makes simulations faster and also allows running electrically large simulations on a single workstation. The test workstation was equipped with a total of 12 CPU cores and 3 GPUs. Results show that the memory-bound FDTD algorithm functions much faster with addition of compute power. The computational efficiency of the OpenMP code scales well with the increase in number of available cores. The multiple-GPU code scales very well for a workstation with multiple GPUs. Simple 1-D grid decomposition was used for splitting the problem domain on multiple GPUs, and the computational efficiency was observed to be close to the theoretical maximum.

Electromagnetic(EM) visualizations of large grid sizes simulated using these parallel techniques will be presented. These visualizations were generated using the VSim EM software package. Computational efficiency and execution times of the parallel computing techniques will be compared. The possibility of using hybrid CPU-GPU schemes with OpenMP and MPI to extend parallelization to multiple workstations/nodes will be discussed. The results of this work show that it is possible to further parallelize the implementation of the FV24 algorithm on a single-node system with considerable improvements in tackling large-scale problems.