GPU-based Parallel PO-SWE Algorithm for the Design of Large-sized Dual-Reflector Antennas

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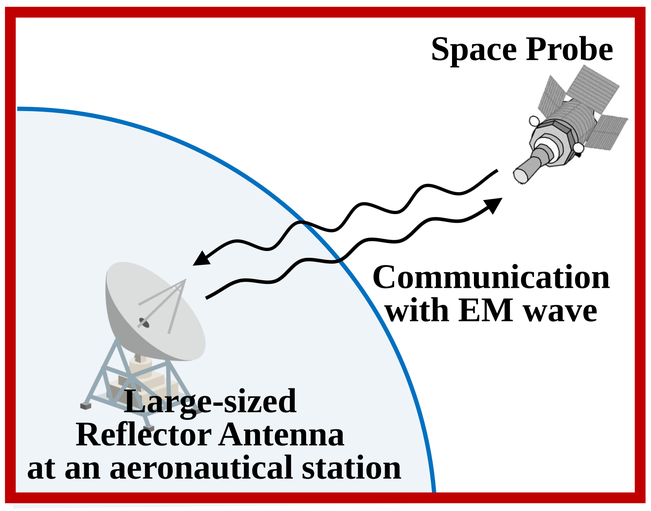
◆Abstract



Large-sized dual-reflector antennas are analyzed to evaluate their performance through long-time simulation using some accurate EM (electromagnetic) methods based on PO (physical optics [1]). To reduce the time/term for the simulation/design, we focused on the parallelization of the fast and accurate hybrid PO-SWE (spherical waveguide expansion [2]) method, which relaxes the computational complexity while maintaining accuracy on a single-node CPU/GPU-embedded system, where each GPU has several thousand cores on a discrete small-sized memory. To perform the hybrid PO-SWE on such a small-sized memory, we developed the CPUs-GPUs distributed algorithm, through which the CPUs iteratively compute the new small-sized regions of the main-reflector and the SWE coefficients of the sub-reflector behind the GPUs-based PO-SWE computation for the pre-computed them. We found that our implementation using 4 GPUs is up to 37 times faster than that using 24-threaded 2 CPUs.

◆Design Flow of Large-sized Dual-Reflector Antenna

・Complex configuration
・Long time simulation

Long term design

Configuration Setting

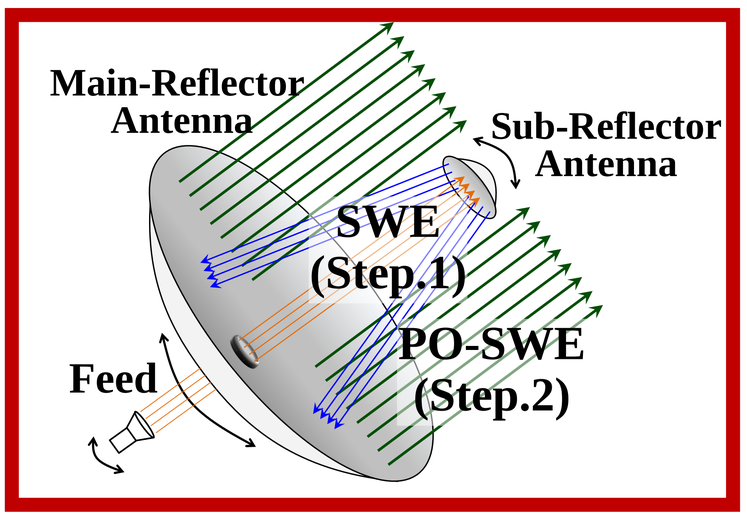
e.g. { shapes of reflectors; positions of feed and reflectors

Feedback

Analysis of Antenna Performance

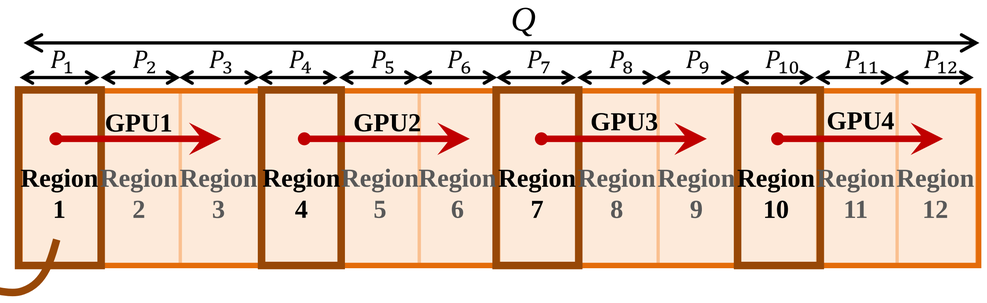
Step.1 : Computation of SWE coefficient matrix
Step.2 : Computation of current distribution using PO-SWE integral with its matrix

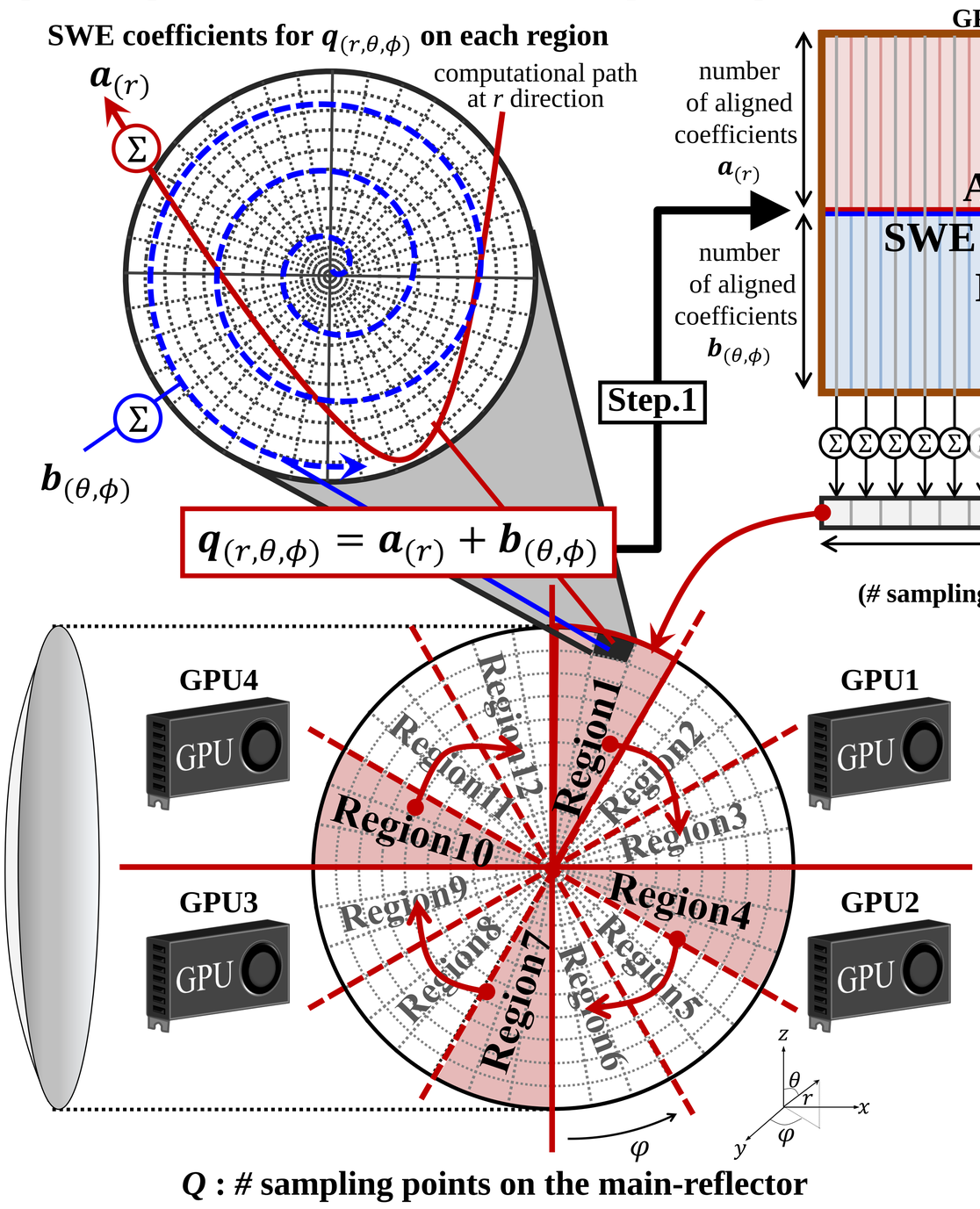
Performance Evaluation

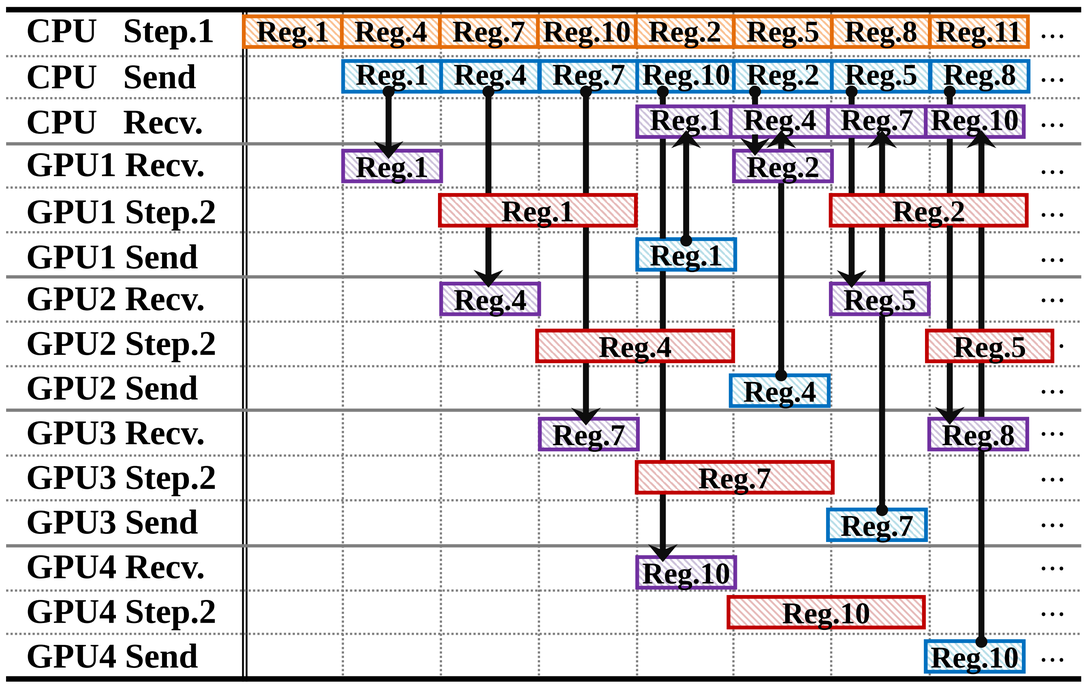


◆Proposed Parallel Algorithm

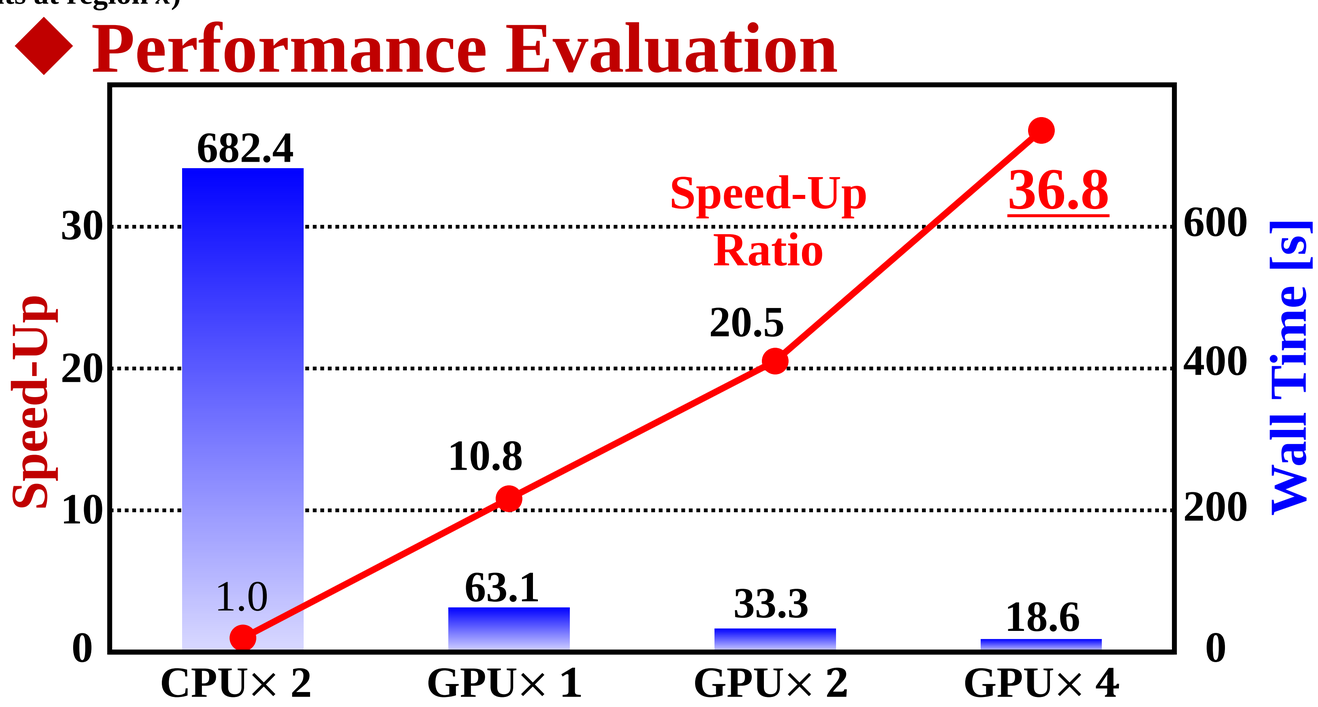
To improve the design efficiency while utilizing GPUs on the fast PO-SWE analysis, we implemented the distributed CPUs-GPUs algorithm for PO-SWE method, through which the CPUs iteratively compute the new small-sized/aligned regions of the SWE coefficients that addresses the divided main-reflector to fit the size of the GPU memory (Step.1). The GPUs compute the PO-SWE integral (Step.2) using the pre-computed results behind the CPU's pre-computation for the next region.







◆Performance Evaluation



CPU	Intel Xeon E5-2690v3 (Haswell) 2 × 2.6 GHz × 12 cores
GPU	NVIDIA Quadro GP100 (Pascal) 4 × 1.4 GHz × 3584 cores

[1] P. Ramanujam, et al. : Different Methods of PO Analysis in a Dual Reflector Antenna With a Shaped Main Reflector
[2] A. Clemente, et al. : Design of a Super Directive Four-Element Compact Antenna Array Using Spherical Wave Expansion