Fast Analysis of Large Reflectarray Antennas Based on Parallel-Computing

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1. Introduction

A large reflectarray antenna is an essential component to establish point-to-point (P2P) communication systems for the millimeter-wave services. In the millimeter-wave frequency band, the electromagnetic wave experiences a bunch of path losses caused by atmospheric environments. To overcome these losses, a large antenna should be used. This is because a large antenna produces high antenna gain which can compensate the severe path losses. One of viable candidates of millimeter-wave high gain antenna is a metal-only reflectarray (MOR) antenna proposed in [1]. A MOR antenna is composed of multiple rectangular grooves in a planar ground plane.

Analyzing a large MOR antenna is very difficult because of its electrical size that is usually greater than 100 wavelengths. As a result, the numerical computation time of a large MOR antenna cannot be ignored. To accelerate the computation time, we proposed an overlapping T-block method based on a standard mode-matching method and the Green's function relations [1]. However, the MOR antenna with its size beyond 100 wavelengths is a really big problem in the antenna design. Thus, we usually adopt parallel-computing procedures [2]-[4] which include OpenMP (Open Multi-Processing), MPI (Message Passing Interface), and GPU (Graphics Processing Unit) CUDA (Compute Unified Device Architecture).

2. Parallel-Computing

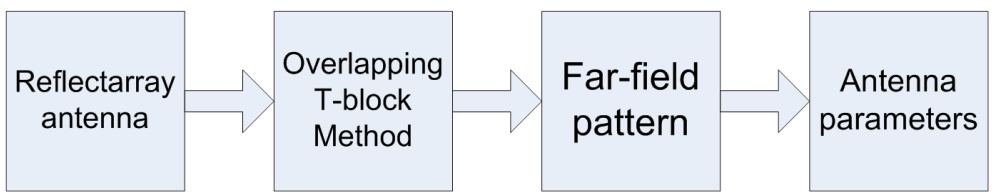

Figure 1. General procedure for the analysis of a metal-only reflectarray (MOR) antenna

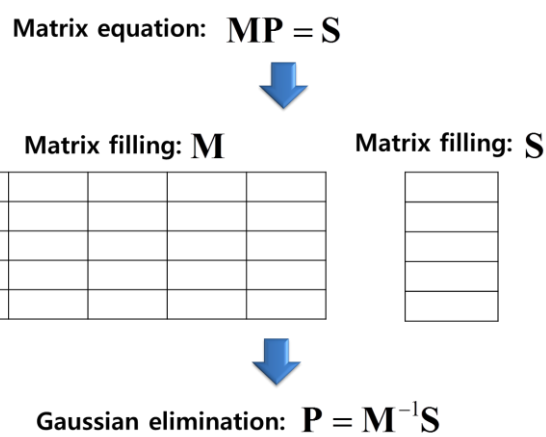

Figure 2. Step-by-step procedure to determine the unknown modal coefficients

Fig. 1 depicts a general procedure to obtain the radiation factors of a MOR antenna. In the radiation analysis, a MOR antenna is divided into multiple overlapping T-blocks which are suitable for the overlapping T-block method [1]. Then, we compose and solve a system of simultaneous linear equations to get the far-field radiation patterns and

pre-defined antenna parameters. During the analysis procedures, solving the system of simultaneous linear equations with matrixes is very important and time-consuming. Fig. 2 shows the detailed steps for solving the matrix equations.

When we analyze the MOR antenna, approximately 80% of computation time is consumed in matrix filling and 20% of 5. For this case, we can consider a GPU CUDA platform. The CUDA hardware usually has more than 1,000 active threads. Thus, using the GPU CUDA for the analysis of large reflectarray antennas can dramatically accelerate the total computation time.

3. References

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