Solution of Radiation Problem for Large-Scale Antenna Array by Using Updated Periodic Equivalence Principle Algorithm

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1. Introduction

When calculating the large-scale periodic antenna array, the full-wave methods are not competent. Researches on the high efficiency approximated method, such as the periodic method of moments (PMM) [1], have received much attention. In the previous work by the present authors, the periodic equivalence principle algorithm (PEPA) [2] was proposed to improve the computational efficiency of PMM. In this paper, an accelerated periodic equivalence principle algorithm (A-PEPA) using the touched equivalence surfaces is proposed to solve the antenna array when the array elements are placed closely.

2. Periodic Equivalence Principle Algorithm (PEPA)

The periodic equivalence principle algorithm is a method combining the periodic Green's function (PGF) with the equivalence principle algorithm (EPA) [3] to estimate the radiation problem of the large-scale periodic antenna arrays. Compared to PMM [1], the number of the unknowns in PEPA is reduced and the times of calculating PGF decreases. Hence the elapsed time is saved.

3. Accelerated PEPA

When the equivalence surfaces enclosing the antenna elements are touched with each other, the currents on the touched face are identical in the amplitudes and reversed in the phases. In PEPA, the ***T*** operator of the translation procedure consists of many series which describe the mutual couplings among the different surfaces. If the touched surfaces are utilized, the contributions of the currents on the touched faces will be offset since the currents are reversed in the phases but identical in amplitudes. Therefore, the ***T*** operator in PEPA can be simplified.

4. Numerical results

A scanning array, in which the antenna elements are often placed closely for suppressing the grating lobe, is considered. One 51×1 quasi-Yagi antenna array with a separation distance of $0.35\lambda_0$ is investigated. The unknowns of each element are 4316 and the unknowns of the surface are 666×2. The excitation of each element is same in the amplitude. The phase difference between the neighboring elements is 70 degrees. In Fig. 1, the radiation pattern of the proposed method is compared with the results from PMM and PEPA. The accuracy is acceptable. The main lobe appears at Theta=35 degrees (Phi=180). The efficiencies of PEPA and the accelerated PEPA are compared in Tab. 1. The CPU time of the proposed method reduces by 42% compared to that of PEPA. The proposed method performs with a higher efficiency.

5. Conclusion

In this paper, one accelerated PEPA was proposed. The touched equivalence surfaces were utilized in PEPA, and the ***T*** operator of the original PEPA was simplified. The efficiency of PEPA was improved by the proposed method and the accuracy was kept.

References

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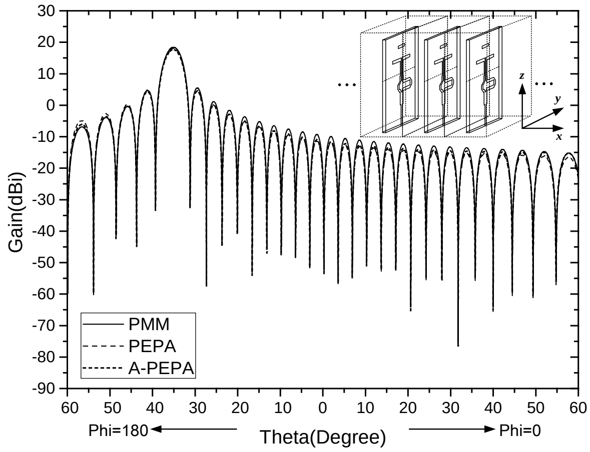

Fig. 1 The comparison of radiation patterns among PMM, PEPA, and the proposed method.

Tab. 1 The comparison of CPU time among PMM, PEPA, and the proposed method.

	PMM	PEPA	Accelerated PEPA
CPU Time	4 hours and 6 minutes	2 hours and 3 minutes	1 hour and 11 minutes