The Hybrid Equivalent Current – Physical Optics Method for Analysis of Arbitrary Onboard Antenna with Large-Scale Platform

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The problem of antenna placement on complex and electrically large platform is a hot topic in electromagnetic compatibility study and antenna design. Currently, the main approach to antenna placement problems is measurement. However, measurement is usually high-cost and takes a long time because several prototypes have to be fabricated and set up for test. Moreover, it is very difficult to build the testing environment for the large-scale realistic platforms, such as ships and aircrafts. So, it is necessary to find an efficient way to predict the onboard antenna performance disturbed by the electrically large platform.

The method of moments (MoM) is widely used to analyze onboard antenna problems but can not handle large-scale structures due to its very high computational cost. The fast algorithms and the higher-order MoM also can not reduce their computational complexity to efficiently solve electrically large structures. The physical optics (PO) is suitable for modeling extremely large structures, and can be hybridized with MoM to greatly reduce the number of unknowns. However, this conventional MoM-PO method is very time-consuming in the calculation of PO contribution for large structures. Then, an efficient iterative MoM-PO (EI-MoM-PO) hybrid method is proposed to simulate the onboard antenna with large-scale platform (Z. L. Liu, and C. F. Wang, IEEE Trans. on AP, vol. 60, no. 7, 3520-3525). This EI-MoM-PO hybrid technique is much faster and maintains the same accuracy with same number of unknowns compared with the conventional MoM-PO method. Besides, the ground effects can also be coupled into the iterative framework of the EI-MoM-PO method to solve half-space problems. However, the realistic applications of the EI-MoM-PO method are limited by two factors: 1) whether the detailed configuration of the concerned onboard antenna is given to us in practice, and 2) whether the MoM code we have can well model the concerned onboard antenna.

To overcome the above limitations, a hybrid equivalent current (EC) – PO technique is proposed in this paper to fully extend the applications of the EI-MoM-PO method. In this novel EC-PO method, it is not necessary to know the detailed structure of the onboard antenna, and only the near electromagnetic fields on a Huygens surface, which encloses the onboard antenna, are required. These EM fields can be obtained from measurement or simulation with commercial softwares. Then a new set of MoM equations can be set up on the Huygens surface, and an iterative process will be implemented to consider the interaction between the onboard antenna and the platform. The detailed formulation and representative examples will be presented at the conference to show how this proposed EC-PO technique can efficiently handle various onboard antennas and arrays installed on large-scale realistic platforms with the good accuracy and reasonable number of unknowns.