The Use of Random Auxiliary Sources for Reflectarray Feed Analysis

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Accurate modeling for reflectarray antenna feeds is performed via using equivalent Random Auxiliary Sources (RAS) problems for both radiating and scattering modes. The developed models are proposed to accurately predict aperture efficiency components for reflectarray analysis. They are also used in an iterative process using the multiple reflection algorithm (P. Kildal *et al*, IEEE Trans. on Antennas and Propagations, 45, 7, 1130-1139, 1997) to accurately predict the gain and radiation pattern of the reflectarray antenna in the presence of the feed.

The proposed equivalent random problems are required to match the near radiated field for the radiating mode and the scattered field for the scattered mode on a closed matching surface enclosing the antenna. These equivalent sources are infinitesimal electric and magnetic dipoles with arbitrary orientations (M. Moharram and A. Kishk, IEEE APSURSI, 1310-1311, 2013). The random distribution of sources within the matching surface is proved to efficiently satisfy a pre-specified square error accuracy level of less than 1% upon introducing enough number of sources that is related to the geometry of the antenna. Moreover, a comparison with a global optimization procedure in sources placement approach (X. Wu *et al*, IEEE Trans. on Antennas and Propagations, 56, 8, 2481-2489, 2008) is invoked resulting in verifying the idea of using random sources, even with larger number of sources, which reduces the model development time while providing acceptable post-processing overhead.

The results of the proposed approach for predicting the theoretical reflectarray antenna aperture efficiency shows very good accuracy in comparison to previously employed approximate methods (A. Yu *et al*, Microwave and Optical Technology Letters, 52, 2, 364-372, 2010). It precisely include the effect of side and back lobes contributions to the models. Also, it includes the exact actual phase of the feed regardless of the knowledge of the phase center location. The multiple reflection method adds further accuracy in gain and radiation pattern prediction from the proposed method without significant computational cost. Nevertheless, this procedure is proposed to be implemented as a plug-in for full-wave solvers for fast reflectarray feed analysis as it is systematic, straight forward and reliable procedure.