Optimizing Aperture Efficiency of Reflectarray Antennas

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A reflectarray antenna is considered as a planar version of conventional curved reflectors. It includes an array of scattering elements and a feeding source as illustrated in Fig. 1(a). The array elements are located on a planar aperture while the feeding source is either center or offset positioned depending on the design requirements.

To initiate the design of a reflectarray antenna system, an estimation of the aperture efficiency is important in order to forecast the anticipated performance. Considering that the aperture efficiency is defined as the product of the two major efficiency parameters, namely the spillover efficiency η_s and the illumination efficiency η_i, it is important to derive the relationship between the aperture efficiency and the reflectarray configuration parameters.

The setup of a reflectarray antenna system is determined by a group of configuration parameters, which describe the aperture geometry, the location, orientation, and beam width of the feed, as well as the beam width of the element patterns. This article investigates the effects of these configuration parameters on the aperture efficiency. First a general and computationally efficient approach is proposed for the calculation of the spillover efficiency of an arbitrarily shaped aperture. Afterwards, the illumination efficiency is studied and a unified set of equations are established for efficiency analysis. An example of the aperture efficiency characterization is shown in Fig. 1(b) as a function of the feed position in the plane of incidence. Based on these derivations and the parametric studies conducted, guidelines for optimizing aperture efficiency of reflectarray antennas are outlined.

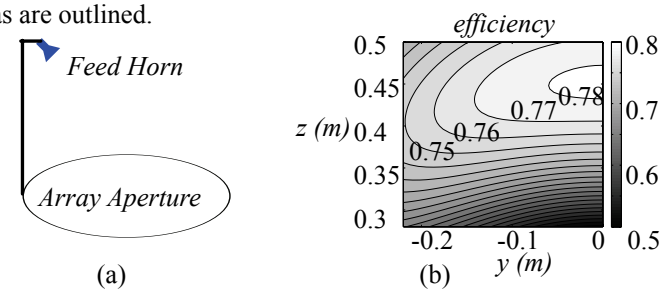

Fig. 1. A reflectarray system: (a) general configuration and (b) computed aperture efficiency versus feed locations.