

Electromagnetic modeling of microstrip reflectarrays using scale changing technique

Farooq Ahmad Tahir^{1,2,*} and Hervé Aubert²

¹*School of Electrical Engineering and Computer Sciences (SECCS), National University of Sciences and Technology (NUST), Sector H-12, Islamabad, Pakistan*

²*University of Toulouse, UPS, INSA, INP, ISAE, LAAS, F-31077 Toulouse, France*

SUMMARY

An efficient numerical technique called scale changing technique is applied here for the electromagnetic modeling of microstrip reflectarrays. Based on the partition of the array surface into further planar sub-domains at various scale levels, this technique allows the computation of the equivalent multipole from the simple cascade of the various scale changing networks. Each network models accurately the electromagnetic coupling between the various sub-domains, including the coupling between non-identical cells in arrays. The high flexibility of the approach associated with advantages of the integral equation formulation renders this original technique powerful and rapid for designing antenna arrays. Because the computation of scale changing networks is mutually independent, processing and memory requirements can be reduced enormously by using multiple processing units. Copyright © 2012 John Wiley & Sons, Ltd.

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KEY WORDS: numerical techniques; integral equation formulations; electromagnetic modeling; surface impedance; scale changing approach; multiscale structures; reflectarray

1. INTRODUCTION

The accurate prediction of electromagnetic (EM) scattering from finite size planar antennas is of great practical interest in the domain of design and optimization of modern reflectarrays, transmit arrays and frequency selective surfaces, but because of their large electrical size and complex cell patterns, full-wave EM analysis of such multiscale structures requires enormous amount of computational resources to resolve prohibitively large number of unknowns. Moreover, the characterization of large array structures would normally require a second step for optimization and fine-tuning of several design parameters as the initial design procedure assumes several approximations. Therefore, a full-wave analysis of the initial design of complete structure is necessary prior to fabrication, to ensure that the performance conforms to the design requirements. A modular analysis technique that is capable of incorporating geometrical changes at individual cell-level without the need to rerun the entire simulation is extremely desirable at this stage.

Historically, several approaches have been followed when analyzing large planar structures. In the case of uniform arrays where periodicity in the geometry exists, an infinite array approach is often applied [1,2]. By using set of Floquet harmonics, the entire computation domain is effectively equivalent to solving for a single unit-cell, thus, significantly reducing the number of unknowns and hence the execution times and memory resources. Although the periodic boundary conditions take the effect of

*Correspondence to: Farooq Ahmad Tahir, School of Electrical Engineering and Computer Sciences (SECCS), National University of Sciences and Technology (NUST), Sector H-12 Islamabad, Pakistan.
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