Guidelines for Student Reports

SYNTHESIS OF METAMATERIAL MICROSTRIP-PRINTED POLARIZERS THROUGH A SYSTEM-BY-DESIGN APPROACH

A. Gelmini

Abstract

Wave polarizers have several applications in those scenarios where a "wave polarization filtering" is required to enhance transmission/reception sensitivity, e.g. in radar, satellite, and communication applications. Towards this end, typical polarizers are based on wire grids, which can be used to enforce linear polarization to the transmitted field. To achieve more complex polarization states, the use of artificial materials consisting of regularly spaced microstrip patches with suitable size and shape on has been recently proposed. However, their optimal design turns out complicated because of the several degrees of freedom at hand (shape of the patch, dimension, orientation, lattice, etc.).
In this project, the design of wave polarizers comprising artificial microstrip-printed metamaterials consisting of an infinite regular grid of suitably designed patches will be considered. More specifically, the aim of the activity will be to design the material composing the polarizer through a System-by-Design (SbD) strategy. Such an approach will comprise a Global Optimization block and a full-wave solver able to effectively deal with periodic structures of equal cells. The overall SbD strategy will therefore work on a "single cell" model, which will be simulated considering periodic boundary conditions. The goal of the synthesis will be to minimize the impedance mismatching for the waveguide-fed phased array when steered. The final result will be the design of a single or multi-layer polarizer based on a planar microstrip-printed metamaterial.

Reference Bibliography: System-by-Design [1]-[3]; Metamaterials [4]-[9].

[1] G. Oliveri, F. Viani, N. Anselmi, and A. Massa, "Synthesis of multi-layer WAIM coatings for planar phased arrays within the system-by-design framework," IEEE Trans. Antennas Propag., in press.
[2] A. Massa, G. Oliveri, P. Rocca, and F. Viani, "System-by-Design: a new paradigm for handling design complexity," 8th European Conference on Antennas Propag. (EuCAP 2014), The Hague, The Netherlands, pp. 1180-1183, Apr. 6-11, 2014.
[3] G. Oliveri, L. Tenuti, E. Bekele, M. Carlin, and A. Massa, "An SbD-QCTO approach to the synthesis of isotropic metamaterial lenses," IEEE Antennas Wireless Propag. Lett., vol. 13, pp. 1783-1786, 2014.
[4] G. Oliveri, L. Tenuti, E. Bekele, M. Carlin, and A. Massa, "An SbD-QCTO approach to the synthesis of isotropic metamaterial lenses," IEEE Antennas Wireless Propag. Lett., vol. 13, pp. 1783-1786, 2014.
[5] G. Oliveri, D. H. Werner, and A. Massa, "Reconfigurable electromagnetics through metamaterials - A review", Proc. IEEE, 2015, in press.
[6] G. Oliveri, E. T. Bekele, D. H. Werner, J. P. Turpin, and A. Massa, "Generalized QCTO for metamaterial-lens-coated conformal arrays", IEEE Trans. Antennas Propag., vol. 62, no. 8, pp 4089-4095, Aug. 2014.

[7] G. Oliveri, P. Rocca, M. Salucci, E. T. Bekele, D. H. Werner, and A. Massa, "Design and synthesis of innovative metamaterial-enhanced arrays," IEEE International Symposium on Antennas Propag. (APS/URSI 2013), Orlando, Florida, USA, pp. 972 - 973, Jul. 7-12, 2013.
[8] I. Martinez, A. H. Panaretos, D. H. Werner, G. Oliveri, and A. Massa, "Ultra-thin reconfigurable electromagnetic metasurface absorbers," EuCAP 2013, Gothenburg, Sweden, April 8-12, 2013.
[9] G. Oliveri, "Improving the reliability of frequency domain simulators in the presence of homogeneous metamaterials - A preliminary numerical assessment," Progress In Electromagnetics Research, vol. 122, pp. 497-518, 2012.

This report is submitted in partial fulfillment of the degree of the course "ACM".
Supervisors: Prof. Andrea Massa, Dr. Giacomo Oliveri.