Guidelines for Student Reports

MULTILAYER STRUCTURE OPTIMIZATION OF ANISOTROPIC MAGNETIC MATERIALS FOR WIDE-ANGLE IMPEDANCE MATCHING (WAIM) IN RECTANGULAR WAVEGUIDE PHASED ANTENNA ARRAYS

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Abstract

A phased-array antenna is a periodic arrangement of antennas that serves the purpose of generating a highly directional radiation whose scan direction can be controlled by the phase gradient applied across the array. If we consider as single radiating element open-ended waveguide, an array can be made opening in a large perfect electric conductor (PEC) plane a set of openings having the same dimensions as the open-end of the waveguide.
To obtain good performance during the scanning operation, it is desirable that the radio of the radiated (transmitted) power be maximized at all output scan angles of the phased-array antennas. Such a ratio depends on the reflection coefficient G and on the effective aperture cross section, f. The reduction of the effective aperture size is a physical limitation, therefore it is especially important to minimize G over a very broad range of angles.
In order to achieve such a goal, in Magill et al. placed a dielectric layer over the array system. These layers are used to optimize the matching over a band of angles but the performance achieved using this method where limited by the inability to implement layers with arbitrarily chosen constitutive parameters. Recently, sophisticated material synthesis techniques have led to the creation of the so called "meta-materials", i.e. artificial materials engineered to have properties that may not be found in nature. Consequently, materials with properly designed constitutive parameters can be used to achieve a WAIM in phased-arrays.
The project follows the approach presented in, but the optimization of the WAIM is performed using N layers of meta-materials placed over the radiating elements, instead of a single layers. The constitutive parameters and the dimensions of the layers placed over on the radiating elements of a phased-array of rectangular waveguides lying on a triangular lattice, will be optimized using the Particle Swarm Optimizer (PSO). The algorithm will minimize a suitable cost function considering the mismatch between the active element impedance and the impedance of the fundamental mode propagating in the waveguide.

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