Pattern Matching by Optimizing Load in a Reflectarray Antenna

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Abstract—**A novel method to match radiation pattern of a reflectarray antenna by optimizing the load is presented in this paper. By varying the load attached to each element in a reflectarray the reflection coefficient at each element is varied, which varies the overall radiation pattern of the reflectarray antenna. This paper addresses the synthesis problem, "What is the optimal loading configuration given a target radiation pattern?" Mathematical solution for computing the optimal load for a target radiation pattern is presented. ADS and MATLAB simulation of a planar printed twenty-one dipoles in one dimension is included for verification.**

Keywords- reflectarray antenna, target radiation pattern, load optimization, reflection coefficient.

I. INTRODUCTION

A reflectarray is an array of antenna elements designed to reflect the incoming wave and selectively couple this to one or more feeding or receiving elements. By varying the parasitic elements (and hence the reflection coefficients of the reflectors), different radiation patterns can be synthesized. Although in traditional reflectarrays, the reflective elements were not reconfigurable [2] [3], figure (1) depicts a more recent example consisting of reconfigurable elements.

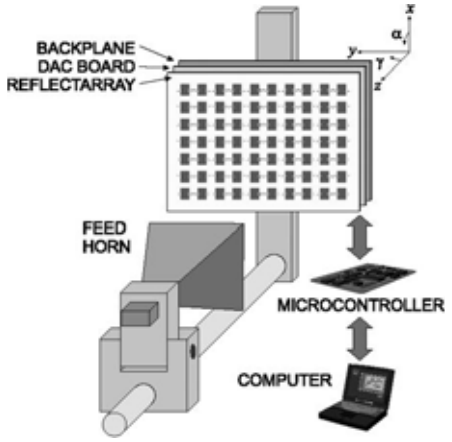

Figure (1). Reconfigurable reflectarray antenna [1]

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Here, the patch reflectarray is externally fed and the reflection coefficient of each patch is controlled by the microcontroller [1].

In a reflect array, each element can be made to reflect the incoming radiation pattern with varying degree as shown in figure (1). By reconfiguring the loads to the elements, the reflection coefficient can be varied [4], which in turn varies the magnitude and phase of the current in the element. This changes the resulting radiation pattern.

The aim of this research however, is to be able to come up with the load configuration of the reflectarray antenna given the target radiation pattern. Generally the requirement of an Engineer is to find the configuration of the antenna such that it resembles a target radiation pattern.

Section II derives mathematical equations in finding the optimal value of Γ_L given a target radiation pattern. The analysis is based on the incoming and reflected waves in a reflectarray antenna with a single feed and N reflectarrays. The optimal value of Γ_L can be obtained by optimization schemes once the S-parameters of the reflectarray antenna and the target radiation pattern is known. In section III a planar dipole reflectarray antenna with a single feed and twenty reflectarrays is created in Agilent ADS. The S-parameter and the radiation pattern of the reflectarray antenna and the elements are exported to MATLAB. Simulation in MATLAB is used to compare the validity of the optimally computed Γ_L for different target radiation patterns set by the user.

II. LOAD OPTIMIZATION

Figure (2) depicts a reflectarray system with a feed (0) and reflectarrays (1,…,N) which was characterized by obtaining the S-parameters of the complete array as well as the pattern of each elements. Given this information, the complete S-parameters of the array can be obtained by simple network analysis where the active port is driven with an incident wave a_0, and the other ports are terminated with individual reflection