Chapter 15
Design and Implementation of Reconfigurable Antennas for Industrial and Medical Applications

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ABSTRACT

Reconfigurable antennas (RA) are capable of dynamically altering their frequency, polarization, and radiation properties in a controlled and reversible manner. They modify their geometry and behaviour to maximize the antenna performance in response to changes in their surrounding conditions. To implement a dynamical response, they employ different mechanisms such as PIN diodes, varactors, radio-frequency microelectromechanical systems (RF-MEMS), FETs, parasitic pixel layers, photoconductive elements, mechanical actuators, metamaterials, ferrites, and liquid crystals. These mechanisms enable intentional distribution of current on the antenna surface producing reversible modification of their properties. This

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chapter presents the design process and applications of RA. The latest advances on reconfigurable metamaterial engineering, and the current trends and future directions relating to RA are reviewed. Finally, the applications of RA in cognitive radio, multi-input multi-output (MIMO) systems, satellite communications, and biomedical devices are highlighted.

INTRODUCTION

Due to the rapid growth of wireless communications, and the high demand for the integration of multiple wireless standards into a single platform, it is highly desirable that the operating frequency, radiation pattern, and polarizations of antennas can be reconfigurable. Reconfigurable antennas modify their operating frequency, impedance bandwidth, polarization, and radiation pattern as per the operating requirements of the host system. They can radiate multiple patterns at different frequencies and polarizations. Obtaining the desired functionality for a reconfigurable antenna and integrating it into a complete system to achieve an efficient and cost-effective solution is a challenging task for antenna designers. Converting an antenna into a reconfigurable device by applying different techniques to change the antenna's internal structure has been challenging. Multiple factors need to be considered such as achieving a good gain, good efficiency, stable radiation pattern, and a good impedance match throughout all the antenna's operation states (T. McMichael, 2018).

To achieve a good gain, stable radiation pattern, and a good impedance throughout the operation states, the reconfigurable antenna designers must focus on the following questions: Which antenna property (e.g. frequency, radiation pattern, or polarization) must be modified? How are the radiating elements of the antenna structure reconfigured to achieve the required property? Which reconfiguration technique can minimize the negative effects on the antenna performances? A reconfigurable antenna provides the same functionality as that given by multiple single-purpose antennas. These offers saving in costs, weight, volume, and maintenance/repair resources (I. Khan, D. Geetha, K.R. Sudhindra, 2018).

The following subsections present the definition of the critical parameters for antenna development. Antenna parameters can be classified into four categories: physical parameters, circuit parameters, transition parameters, and space parameters. The physical parameters include size, material, temperature, wind pressure, supporting structure, and coating. The circuit parameters include input impedance, bandwidth, radiation resistance, self and mutual inductance and gain. The transition parameters include loss, attenuation and mismatch. Finally, the space parameters are radiation pattern shape, beam width, directivity, radiation intensity, lobes and polarizations.