

Fast and Accurate Model to Determine the Resonant Characteristics of Elliptical Microstrip Patch Antenna

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Abstract—In this work, artificial neural networks are used in the design of a microstrip antenna of elliptical geometry. We propose two neural models. In the first one, the outputs of the problem are the patch size and the resonant frequency for even modes. In the reverse side of the problem, the resonant frequencies for both even and odd modes are obtained in terms of the effective semi-major axis, eccentricity of elliptical patch, the thickness and the effective relative permittivity of the dielectric substrate. To enhance the accuracy of the two models, measurements have been included in the training stage. The two proposed models are very adequate for a fast and accurate estimation of the characteristics of the elliptical microstrip antenna.

Keywords—dual-resonant frequency, elliptical microstrip antennas, artificial neural networks

I. INTRODUCTION

The development of modern communication systems requires technological progresses in electronic components, computer software, coding techniques and antennas. In fact, the antenna is one of the key points of modern communication systems since this element is the last link in the chain allowing the transmission and the reception of the information. Actually, microstrip antennas are among the most popular type of antennas used in modern communication systems [1]-[2]. This type of antenna is made by depositing a metallic patch of neglecting thickness on a grounded dielectric slab. Several geometries are possible for the radiating patch. The most popular are rectangular, circular, triangular and annular.

In this manuscript, the geometry selected for the conducting patch is elliptical. This choice is motivated by the numerous advantages which are offered by the elliptical microstrip antenna for a diversity of electrically small low profile antenna applications. In the design stage, the elliptical geometry provides more degrees of freedom relatively to the circular shape. Another advantage of the elliptical antenna is the possibility to obtain circular polarization with only a unique feed. Little theoretical works have been achieved concerning the elliptical microstrip patch antenna compared to the other regular geometries owing to difficulties encountered in the mathematical analysis of this antenna. This difficulty is mainly due to the requirement of Mathieu's and modified Mathieu's functions in the analysis procedure. Theoretical researches of microstrip patch antenna having elliptical geometry are abundant. In these researches, the resonant frequencies for both even and odd modes are estimated in terms of the physical and geometrical parameters of the elliptical antenna [3], [4]. Note that compared to the circular shape, the

elliptical one have two dimensions, namely, the major and the minor axis [5]. However, the inverse calculation of the elliptical patch size assuming that the resonant frequencies for even and odd modes as well as the parameters of dielectric substrate are known. In the present work, we use artificial neural networks as an efficient tool to compute the major and the minor axis of the elliptical patch.

II. RESONANT FREQUENCIES FOR EVEN AND ODD MODES

The elliptical microstrip patch antenna under study is depicted in Fig. 1. Here, we have a metallic patch of elliptical geometry deposited on a grounded dielectric substrate of thickness h and relative permittivity ϵ_r . The elliptical patch is characterized by the two dimensions a and b , which are the semi-major and the semi-minor axis, respectively.

A. Dual-Resonant Frequency Formula

With the aim of obtaining the resonant frequencies for both even (f^e) and odd (f^o) modes, we use as a support the theory of elliptical waveguide developed in [6]. This yields to the following equation

$$f_{11}^{e,o} = \frac{15}{\pi a} \sqrt{\frac{q_{11}^{e,o}}{\epsilon_r}} \quad (1)$$

In equation (1), the subscript 11 stands for the TM_{11} mode. $e = \sqrt{1 - (b/a)^2}$ is the eccentricity of the elliptical radiating patch. In order to take into account the influence of the fringing fields at the edge of the elliptical patch, the physical semi-major axis a is replaced by an effective one

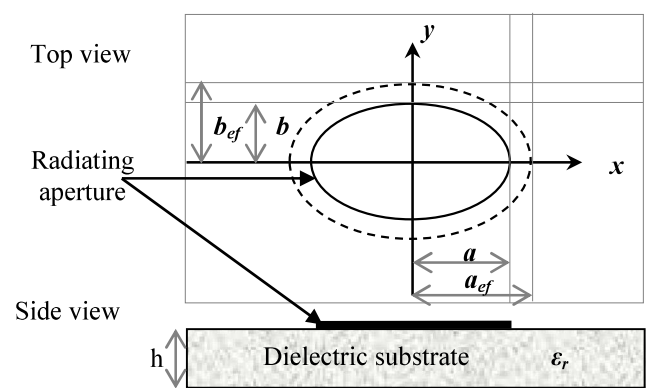


Fig. 1. Elliptical microstrip antenna with their effective parameters.