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A REVIEW PAPER ON MICROSTRIP PATCH ANTENNA DESIGN USING NEURAL NETWORKS

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Abstract

In the microwave community, artificial neural network (ANN) modelling has recently acquired huge attention across the globe, especially in the analysis and synthesis of microstrip antennas (MSAs) due to their generalisation and adaptability characteristics. A trained neural model, that is almost identical to its measured as well as simulated equivalent, determines the response very fast. It also completely bypasses the repeated use of traditional models, as these models demand to be re-discretized for any small geometry change, which is a time-consuming exercise itself. The ultimate objective of this survey paper is to comprehensively study this emerging field for both analysis as well as the synthesis of the MSAs. Some of the untouched cases, that are basically required for the antenna designers to be resolved, are also observed during the review procedure. Unique and efficient solutions rooted on the neural networks are suggested for these instances. The existing proposed neural methods are also verified by the prototypes' fabrication and characterization.

Keywords: *Antenna Modelling; Microstrip Patch Antennas; Slotted Microstrip Antennas; Air-Gap; Neural Networks.*

I. INTRODUCTION

Due to several attractive characteristics, microstrip antennas (MSAs) have become very common in communication applications since their inception in the early 1970s. Analysis and synthesis are two separate approaches to identify the problems with the antenna [1]. The study deals with the determination of its output parameters, such as resonance frequency, gain, directionality, bandwidth, and patterns of radiation [2]. The study of the MSAs uses many empirical and numerical approaches [3].

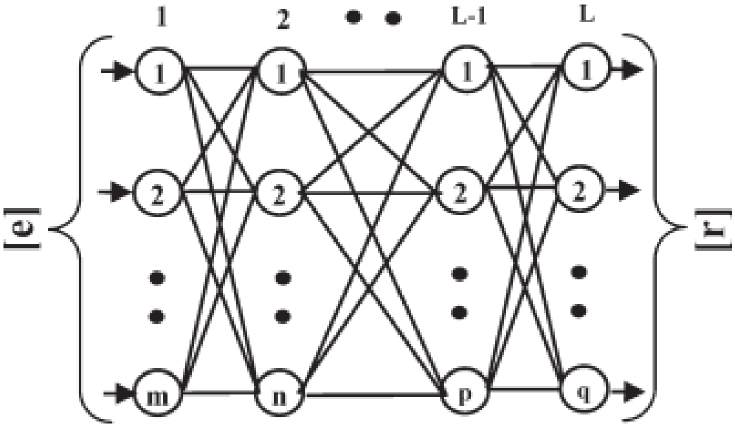

Fig. 1 Shows the MLP neural networks modelling [4].

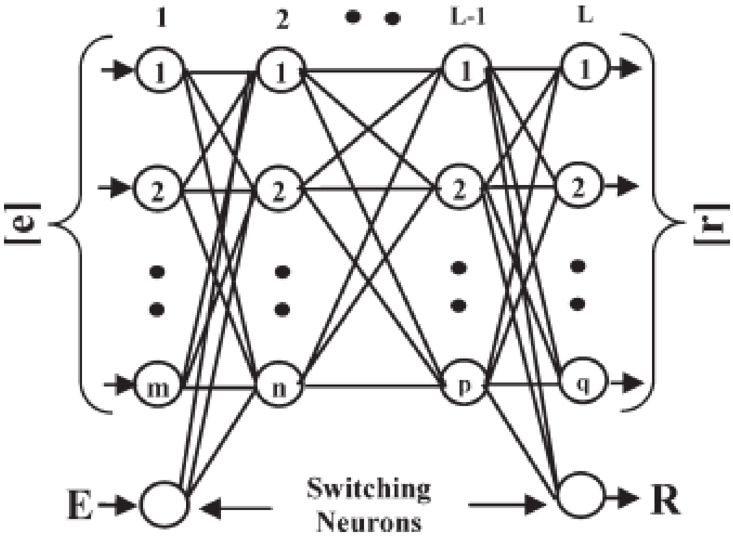

Fig. 2 Illustrates the simplified MLP neural networks archetypal [4].

The analytical techniques are detailed and provide extensive information for the application of standard patch geometries as well. These techniques, however, are based on physical principles and are only sufficient for thin substrates [5]. In comparison, for arbitrarily formed MSAs, numerical methods provide fairly good results, but only at the expense of mathematical complexities in the form of integral equations [6].

The width W of the DRA antenna can be determined by utilizing the following equation.

$$w = \frac{c}{2\,f_r\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where

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f_r denotes the resonant frequency, and
r represents substrate dielectric constant

The effective dielectric constant (ε_{reff}) of DRA antenna is derived by using the following equations.

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2} \sqrt{\left(1 + 12\frac{h}{W}\right)}$$

Where h denotes the height of the antenna and W denotes the width.

The length of the antenna may be measured by applying the following equation.

$$L = \frac{c}{2\, f_r \sqrt{\varepsilon_{reff}}}$$

The antenna length extension is calculated by applying the equation below.

$$\Delta L = 0.412\, h \,\frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{W}{h} + 0.246\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}$$

Here W represents the width and h denotes the height.

The real length (L_{eff}) of the antenna can be calculated by using the following formula.

$$L_{eff} = L + 2\Delta L$$

II. LITERATURE REVIEW

A study was performed on the circularly polarised microstrip patch antenna by Kumar et al. A triple-frequency single-feed S-shaped circularly polarised microstrip antenna with a minimal frequency ratio has been proposed for mobile communication and GPS applications. An S-shaped slot is removed in the centre of a square patch of 84.5 to 84.5 mm2 for multi-band service. A single microstrip line with an aperture-coupled feeding structure consists of the proposed antenna geometry. The results of the simulation show that the proposed antenna can be used at 1.193 GHz, 1.454 GHz and 1.615 GHz with an effective return loss of -34.34 dB, -18.23 dB and -24.75 dB respectively for multiband antenna [7].

A survey on microstrip antenna architecture using neural networks was conducted by Vilovic et al. Because of their features such as small dimensions, simplicity, conformability and low production costs, Microstrip antennas became very attractive. The development of these wireless communication antennas is based on the design of reliable, wide-band antennas that can be easily integrated into different systems. It is important to measure the design parameters of the microstrip antenna with very high precision to ensure proper functioning. The rectangular or circular microstrip patch antenna design requires high calculation accuracy, and the task is not so easy [8].

III. DISCUSSION AND CONCLUSION

A study cum survey on analysis and synthesis of MSAs using various techniques of neural networks has been defined in this article. Several instances of patch and slot antennas have been targeted. Various constraints in terms of structural configuration, measured errors, training time, necessary epochs, and so on have been found during the analysis of the literature on neural modelling of patch antennas. A few more powerful neural models for patch antennas have been proposed by various scientists.

Initially, the single efficiency parameter estimation of different patch antenna geometries was addressed. In order to compute various output parameters, a generalised neural approach was then addressed, as it is very much appreciated by antenna designers. The generalised neural modelling literature has been extensively reviewed, and it is found that these referenced models are either based on the definition of the analogous region or alternating between the forward and reverse side of a model.

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