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A New AI Approach for The Predicting Resonance Behavior of Microstrip Antenna

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***Abstract*— The purpose of this work is to understand and unambiguously prove the best novel computational approach for microstrip antenna design. To design an improved model of microstrip antenna, which algorithm of artificial intelligence has been used for prediction.**

Keywords*— *Microstrip antennas, Artificial Intelligence (AI), Artificial Neural Network (ANN).

I. Introduction

The main objective of this work is to predict the resonant frequency for microstrip antenna design by artificial neural network (ANN). It is observed that the use of "Artificial Intelligence" is most convenient and helpful. It is cost effective and time saving as well as very suitable for better model designing. ANN and its various important algorithms are used to perform the prediction and synthesis tasks. ANNs have been instrumental in designing "microstrip antennas", which have gained popularity in wireless communication systems due to their low profile, light weight, and ease of manufacture.

Artificial Intelligence (AI) is the development of computer systems that can perform tasks that typically require human intelligence. This involves using algorithms and statistical models to enable machines to learn from data, adapt to new inputs, and perform tasks that would normally require human intelligence. Within the field of AI, there are various concepts, including Machine Learning (ML), Deep Learning (DL), and Artificial Neural Networks (ANNs). ML focuses on developing algorithms and statistical models that enable computers to learn from data and improve their performance on a specific task without being explicitly programmed. DL is a subset of ML that uses ANNs to process large amounts of data and learn from it. ANNs are a fundamental component of DL and are inspired by the structure and function of the human brain. ANN is a general term that encompasses a wide range of network architectures, including feedforward, convolutional, and recurrent neural networks [8-17]

A microstrip antenna is a type of antenna that is designed using microstrip technology, which involves placing a metal patch on a dielectric substrate. The patch acts as the radiating element, while the substrate acts as the supporting structure for the antenna. Microstrip or patch antennas can be easily printed on a circuit board, so they are becoming increasingly useful in wireless communications, mobile, radio and satellite applications, as well as in spacecraft, missiles, airships. [1-7]. A microstrip antenna, built on the ground plane, whose patch dimensions are width W and length L, and substrate thickness h, and dielectric constant εr as given in (fig 1).

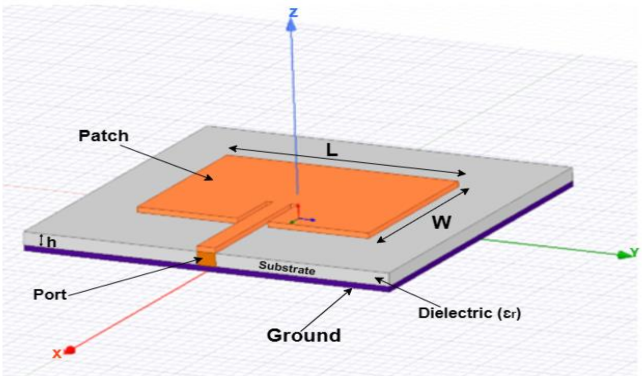

Fig. 1. Schematic of Microstrip Patch Antenna

II. Recent Works on Application of AI in Microstrip Antenna

Artificial neural networks (ANNs) have proven to be efficient in the design and analysis of micro-strip antennas, providing accurate results with low computational costs [1]. ANNs are particularly attractive for micro-strip antenna design due to their ability to represent the relationship between antenna parameters and provide accurate results [2]. Both Multi-layer Perceptron (MLP) and Radial Basis Function (RBF) networks have been employed in ANN models for micro-strip antennas, with MLP networks being trained with various learning algorithms [3]. ANN algorithms, including Feed Forward Back Propagation Algorithm (FFBPN), Resilient Backpropagation (RPROP), Levenberg-Marquardt (LM), and Radial Basis functions (RBF), have been used to obtain the resonant frequency of micro-strip antennas [4]. ANNs offer advantages over traditional methods of analysis and design that introduce simplifications leading to errors in determining antenna parameters [5]. ANNs have the potential to be used as a tool in the design of many microwave circuits due to their superior computational ability, high degree of interconnectivity, and accuracy in modeling highly non-linear responses [6].

III. Basic Microstrip Antenna Geometry

A conventional rectangular microstrip antenna has been considered with dielectric substrate (ε_r = 2.33, height h = 1.575 mm). The patch length (L) and (W) have been varied following the approach presented in [7] to theoretically calculate resonant frequency of the antenna. The probe feeding method has been considered (Fig 1).

IV. Results and Discussions

In this work the result for resonant frequency of microstrip antenna design is obtained by using different algorithms and techniques of artificial neural network. Data transformation is predicted using the TRAINRP function and nntool. Data from 5 samples of more than 250 data for the resonant frequencies were validated with error between theoretical and predicted in the range of 1 to 2.5 as shown in Table-I.

TABLE I. PREDICTION OF THE RESONANT FREQUENCY THROUGH ANN

W (mm)	L (mm)	Freq in GHz (Theoretical)	ANN Freq. (GHz) (Predicted)	ERROR
12	11	7.9986	6.081563988	1.917
12	12	7.4581	6.081563988	1.3765
14	11	7.8728	5.777525482	2.0953
14	12	7.3545	5.777525482	1.577
14	13	6.8945	5.777525482	1.117

Data Prediction by ANN. (Result & Error)

Most of the study is required to reduce the error in the prediction of the resonant frequency of the patch and in future work approaches will also be validated against measurements.

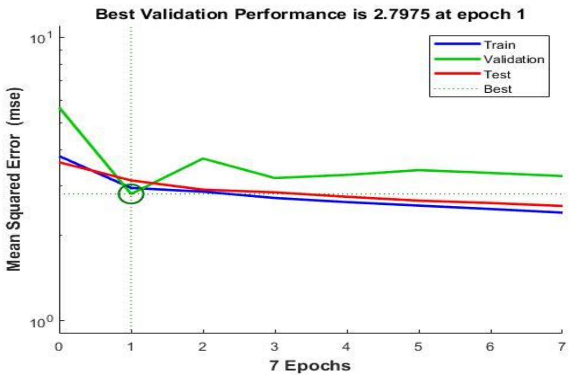

Fig. 2. Plot the Performance.

The performance of resonant frequency prediction tests such as train, validation and test is depicted in the performance graph of figure-2.

Aknowledgement

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