Chapter 20
Designing and Analysis of Antenna Using Back Propagation Network

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ABSTRACT

This chapter deals with the designing of an antenna using computational intelligence algorithm (i.e., ANN). An artificial neural network (ANNs) based on back propagation network (BPN) is demonstrated for the designing of an antenna. Initially, the ANN is trained with an adequate number of samples. Once the ANN is trained, it can be used to get antenna parameters corresponding to specific antenna dimensions. The antenna parameters obtained using ANN is compared with the results taken by Ansoft HFSS.

INTRODUCTION

This chapter deals with the designing of an antenna using computational intelligence algorithm i.e. ANN. An artificial neural networks (ANNs) based on back propagation network (BPN) is demonstrated for the designing of an antenna. Initially, the ANN is trained with adequate number of samples. Once the ANN is trained, it can be used to get antenna parameters corresponding to specific antenna dimensions. The antenna parameters obtained using ANN is compared with the results taken by Ansoft HFSS.

The advantage of using ANNs based antenna design approach is that the complex repetitive procedure of designing and analysis of antenna gets simplified. Antenna design using ANN to predict the output parameters by varying geometrical dimensions of various shapes such as square patch (Mishra,

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& Patnaik,1998), rectangular patch structure(Narayana, Krishna, & Reddy, 2007; Sharma, Kumar, 2015; Aneesh, Ansari, Singh, Kamakshi & Verma, 2012), circular patch (Mishra, Janvale, Pawar, & Patil, 2011), fractal circular slot antenna based on Artificial Neural Networks (ANNs) has been designed in (Sivia, Pharwaha & Kamal, 2013). The Proposed antenna is simulated up to 2nd iteration using method of moment based IE3D software. Antenna is fabricated on Roger RT 5880 Duroid substrate (High frequency material) for validation of simulated, measured and ANNs results. Properly trained neural network completely bypasses the complex iterative process for the design and analysis of this antenna which is the main advantage of artificial neural networks. Using artificial neural networks the results obtained are according with the simulated and measured results. The basic reason of applying neural network in this paper is to change the long investigation and design cycles necessary to develop high performance system to very short product development time. The projected technique has used FFBP-ANN with one hidden layer as an approximate model for design and analysis of circular fractal antenna. The results of ANNs for estimation of design and analysis parameters are according to the simulated and measured results. From the results it is observed that under specified conditions the proposed modeling technique is very suitable to model ANNs for predicting the design parameters (Sivia, Pharwaha & Kamal, 2013) and in (Khan, & De, 2014) has proposed a knowledge-based neural networks model for predicting the appropriate shape and accurate size of the slot introduced on the radiating patch for achieving desired level of resonance, gain, directivity, antenna efficiency and radiation efficiency for dual-frequency operation. Additionally, the neural model incorporated with prior knowledge can be used for predicting response in extrapolation region beyond the training patterns region. For validation, a prototype is also fabricated and its performance parameters are measured. A very good harmony is attained between measured, simulated and predicted results. Moreover, slots of different shapes and sizes (Khan & De, 2014; Araujo, d'Assunção & Mendonça, 2010) have proposed. ANN has also been implemented to predict various output parameters of antenna such as radiating frequency (Guney & Gultekin, S. S, 2004), radiation pattern ((Neog, Pattnaik, Panda, Devi, Khuntia & Dutta, 2005), bandwidth ((Thakare & Singhal, 2009), input impedance (Kim, Keely, Ghosh & Ling, 2007). etc.

In this chapter, different types of patch antennas and their parameters are presented in section 1. Section II represents the different types of feeding technique used to design an antenna whereas; Section III gives the detailed description of BPN algorithm. Section IV gives the analysis of antenna using BPN. Finally, the conclusion of the proposed work is presented in Section V.

SECTION I

1.1 Microstrip Antenna

The concept of microstrip antenna is first given by Deschamps in 1953 and the first practical antenna is developed by Howell and Munson in 1970 (Garg, Bhartia, Bahl & Ittipiboon, 2001) Microstrip antenna comprises of a substrate with a radiating patch printed on one side of a dielectric substrate and a ground plane on the other side of the substrate. The patches and ground plane are of good conducting material such as copper, gold etc. Microstrip antennas offer number of advantages such as (Garg, Bhartia, Bahl & Ittipiboon, 2001; James, 1989):-