International Journal of Power System Operation and Energy Management

Volume 3 | Issue 2 Article 7

April 2014

Fast Extraction of Resonant Frequency of Square Ring Micro-strip antenna using Neural Network Approach

Prabhat K. Patnaik
Dept of E.C.E, S.O.E.T Centurion University of Technology & Management, Paralakhemundi, India,
prabhat.ku.patnaik@gmail.com

P. Santosh Kumar
Centurion University of Technology & Management, Paralakhemundi, India,
pantinasantosh143@gmail.com

Prabhakar Nayak
Centurion University of Technology & Management, Paralakhemundi, India,
prabhakar.nayak26@gmai.com

Recommended Citation

Patnaik, Prabhat K.; Kumar, P. Santosh; and Nayak, Prabhakar (2014) "Fast Extraction of Resonant Frequency of Square Ring Micro-strip antenna using Neural Network Approach," *International Journal of Power System Operation and Energy Management*: Vol. 3 : Iss. 2 , Article 7.
DOI: 10.47893/IJPSOEM.2014.1130
Available at: https://www.interscience.in/ijpsoem/vol3/iss2/7

Fast Extraction of Resonant Frequency of Square Ring Micro-strip antenna using Neural Network Approach

Prabhat K. Patnaik Asst. Professor Dept of E.C.E, S.O.E.T Centurion University of Technology & Management, Paralakhemundi, India prabhat.ku.patnaik@gmail.com

P. Santosh Kumar
B.Tech Student
Dept. of E.C.E, .O.E.T
Centurion University of Technology & Management, Paralakhemundi, India
pantinasantosh143@gmail.com

Prabhakar Nayak
B.Tech Student
Dept. of E.C.E, S.O.E.T
Centurion University of Technology & Management, Paralakhemundi, India
prabhakar.nayak26@gmai.com

Abstract – This paper presents an efficient approach based on neural network to design a square ring micro-strip antenna. Traditional techniques used to design a square ring antenna are based on EM field simulations like IE3D which is highly CPU intensive and requires lot of time for simulation. Neural networks can be used to map the complex relationship between physical and electrical parameters of ring antenna in an efficient manner. The model once developed can be used with minimal CPU resources and enables fast extraction of output parameter such as resonant frequency. The typical resonant frequency values are first obtained through IE3D and then from samples obtained from IE3D are used to train the neural network .The results obtained by the use of neural networks have been proved to be faster than comparison with IE3D software.

Keywords- Square Ring Microstrip Antenna; Resonant Frequency; IE3D;NN

I. INTRODUCTION

The rectangular patch is the most commonly used microstrip antenna, and is characterized by its length and width[1]. Another configuration is the circular patch antenna and its geometry is characterized by a single parameter, namely, the radius. It was found that for the ring resonator, the resonant frequency of the lowest order mode can be much lower than that of the circular disc of approximately the same size. The separation of the modes can be controlled by the ratio of its outer to inner radii.

A novel structure that has not been studied well yet is the square-ring patch, which is geometrically an intermediate configuration between a printed loop and solid patch. The intermediate configuration is similar to the patch, except its central conducting portion of width W2 is removed. This width W2 provides a new parameter to control its resonance and impedance

This is a method for miniaturization of microstrip patch antenna without degrading its radiation[2] .It involves perforating the patch to form a microstrip square-ring antenna, which is investigated through simulations .The ring geometry introduces additional parameters to the antenna that can be used to control its impedance ,resonance frequency, and bandwidth. For a single square ring increasing the size of perforation increases its input impedance, but decreases the resonance frequency and bandwidth. It has a small effect on directivity of the antenna. In this paper we have a detailed study of how to design and fabricate a probe-fed Square Microstrip Patch

Antenna using IE3D software and study the effect of antenna dimensions Width, relative Dielectric constant (εr) of the substrate, substrate thickness(t) on the resonant frequency of the antenna[6].

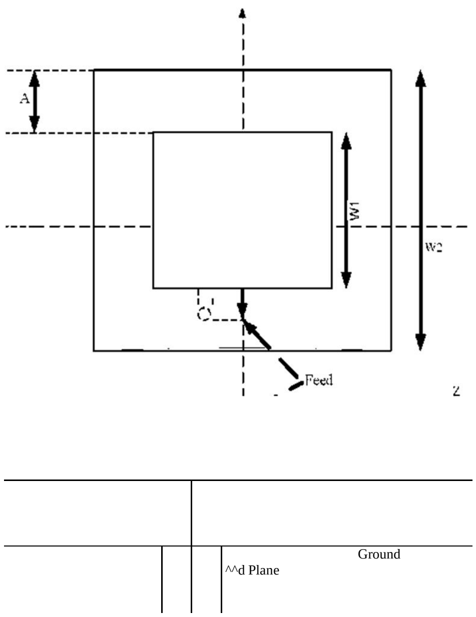

Figure 1. Microstrip Square Ring Configuration

The printed ring antenna is similar to a solid patchexcept that its central conducting portion W2 is removed. In order to study the characteristics of a square-ring resonator, a solid patch with width W1=5 mm,15 mm,25mm are taken and dielectric substrate relative permittivity of 2, 4, 6, 8 are taken and thickness 0.5mm, 1.5mm, 2.5mm is considered. The ground plane is assumed infinite and the patch is fed coaxially as shown in figure. Extensive computations are carried out to obtain the characteristics of the ring antenna.

From the data obtained through EM field simulations using IE3D we train a neural network which is a efficient way for the fast extraction of EM field data.

II. NEURAL NETWORK

Neural Network consists of neurons and interconnects. Each neuron has weighted inputs, activation function and output. Output of each neuron is function of weighted sum of inputs. The function is called activation function. A log sigmoid function is generally used as activation function in the input layer and linear activation function is used in the output layer. The activation function introduces non-linearity and produces the output. Neural networks generally designed with layers of neurons. A three layer neural network is sufficient to adapt any kind of non linearity[5] . Knowledge is acquired by NN with help of training. Previous measured or simulated input output is presented to NN called as training process. During training process, the inter-unit connections are optimized until the error in prediction is minimized. Once the network is trained, new unseen input information is entered to the network to calculate the test output. The procedure of extracting data is shown in figure below.

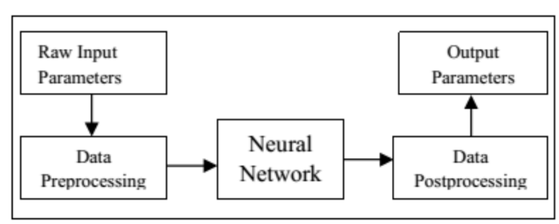

Figure 2. NN Implementation process

III. PRESENT METHOD

A three layer NN 2x10x2 is choose to implement the model on hit and trail basis. Width of main patch W1, width of the square ring W2, dielectric constant of the substrate(εr), and substrate thickness „t" are taken as the inputs for the neural network model. Resonant frequency (fr) for each variation of individual parameters is taken as the output of neuralnetwork model. W1 is varied from 5mm to 25mm, W2 are varied from 0 mm to 10mm, substrate thickness(t) varied from 0.5 to 2.5 and dielectric constant of the substrate varied from 2 to 8. 75 patterns extracted from EM parameterisation is used to train the neural network model.

NN tool box of Matlab is used to train the neural network. Back Propagation algorithm is selected for training. The total training time 23mins. 0.0025 for 75 patterns is fixed as mean square error target. Then a new available dataset (10 no of patterns) of various W1, W2,ϵr,h are given as input and the trained network is simulated to obtain the values of fr.

Various plots of performance, training state and regression of NN are obtained and studied.

IV. RESULTS

The simulated outputs from EM field simulations are in good agreement with the simulated data from the neural network. As shown in Table 1, a comparison is done with the resonant frequency(fr) values of the EM simulation results and NN values. The resonant frequency(fr) values obtained from NN model are in close agreement with EM simulation results.

TABLE1. Comparision of Simulated Resonant Frequency and NN Resonant Frequency

t (in mm)	Er	W1(in mm)	W2(in mm)	f_r(from IE3d) In GHz	f_r(from NN) In GHz
0.5	2	15	4	9.6	14.9468612
0.5	4	5	3	13.56	13.3151498
0.5	4	15	0	17.86	16.1017182
1.5	2	5	1	17.86	16.6964649
1.5	6	5	1	11.533	11.3608638
1.5	6	15	3	11.533	14.2553058
2.5	4	5	1	11.56	12.4511390
2.5	6	5	1	9.46	9.90318410
2.5	8	5	2	9.43	9.11974053
0.5	2	25	0	17.8	16.8393677

V. CONCLUSION

In this paper a fast extraction of resonant frequency of electromagnetically coupled square ring microstrip antenna is done using neural network .It

has been found that the output data i.e., the resonant frequency obtained using Neural networks are in close approximation with the outputs obtained from IE3D.Thus a faster alternative for extraction of resonant frequency of square ring microstrip antenna implemented.

REFERENCE

[1] S.Behera and K.J.Vijoy , “Microstrip Square ring antenna for dual band operation” Progress In Electromagnetics Research, PIER 93, 41–56, 2009.
[2] Pedram Moosavi Bafrooei, “Characteristics of Single- and Double-Layer Microstrip Square-Ring Antennas” IEEE Transactions on Antennas and Propagation, Vol. 47, No. 10, October 1999.
[3] Design of Square-ring microstrip antenna for circular polarization. By J.S.ROW ELECTRONICS LETTER 22nd January 2004 vol.40 No.2
[4] G. P. Zhang, "Neural networks for classification: a survey," Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on, vol. 30, pp. 451-462, 2000.
[5]S. Devi, D.C. Panda, S.S. Pattnaik, “A novel methodof using artificial neural networks to calculate input impedance of circular microstrip antenna”, Antennas and Propagation Society International Symposium, Vol. 3, pp. 462 – 465, 16-21 June 2002
[6]www.europractice.stfc.ac.uk/vendors/mg_ie3d-si-ds.pdf