Volume 4, Issue 12, December 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Design of Triangular Microstrip Antenna Using Quasi-Newton Algorithm of ANN

Jagtar Singh Sivia*
Associate Professor ECE Yadavindra College of Engineering Punjabi University Guru Kashi Campus, Talwandi Sabo Punjab India

Abstract—This paper presents Artificial Neural Network (ANN) model as alternative method for the design of triangular microstrip patch antenna. The proposed technique uses Feed-Forward Back-Propagation Artificial Neural Network (FFBP-ANN) with one hidden layer and trained with Quasi-Newton algorithm as an approximate model for the design of triangular microstrip patch antenna. The Method of moments (MoMs) based IE3D software has been used to generate the data for training and validation of ANN. The result shows very good agreement simulated results.

Keywords— Triangular, Microstrip, Antenna, Quasi-Newton, Artificial Neural Networks

I. INTRODUCTION

Microstrip antennas are used in a wide range of mobile communication applications which demands for multi-band and wide band operation, high power gain, Omni-directional radiation patterns etc. [1]. In high -performance space craft ,aircraft, missile and satellite applications where size, weight, cost, performance, ease of installation and aerodynamic profile are constraints, low profile antennas may be required [2] A microstrip antenna consists of a very thin metallic patch placed a small fraction of a wavelength above a conducting ground plane. The strip and ground are separated by a dielectric sheet referred as substrate. The radiating element and feed lines is normally photo etched on dielectric substrate. The radiating patch conductor is generally of copper and can assume any shape square, rectangular, circular, elliptical, triangular or any other desired configuration [3]. The operational disadvantages of micro-strip antennas are their low efficiency, low power, high Q, poor polarization purity, poor scan performance, spurious feed radiation and very narrow frequency bandwidth, which is typically only a fraction of a percent or at most a few percent [4]. There are many methods for calculating the parameters of microstrip antenna but getting the actual data for developing real prototype for experiment is found difficult. ANN offers a viable solution to obtain design parameters [5]. Sufficient amount of work indicates how ANN can be used efficiently to design rectangular and circular microstrip antenna [6-11]. Mishra et al designed Circular Microstrip Patch Antenna by Using Quasi-Newton Algorithm of ANN [5]. In this paper triangular microstrip antenna is designed using Quasi-Newton Algorithm of ANN. The Method of moments (MoM) based IE3D software has been used to generate the data dictionary for training and testing of ANN. The proposed technique uses Feed-Forward Back-Propagation Artificial Neural Network (FFBP-ANN) with one hidden layer and trained with Quasi-Newton algorithm as an approximate model for the design and analysis of triangular microstrip patch antenna.

II. DESIGN AND ANALYSIS OF ANTENNA

The design of triangular microstrip antenna includes the specified information of frequency (f_r), height of substrate (h) and dielectric constant (ε) of substrate material. So we can find side length triangular microstrip antenna with the information of above parameters by using IE3D software. For example for the analysis of triangular micostrip antenna side length of patch s =10.4mm, height of substrate h= 1.60mm and dielectric constant ε =2.3 is taken. Then triangular patch is energized by using coaxial feed at distance of 3.81mm from the vertex of triangular antenna as shown in Figure 1.Then antenna is simulated by using IE3D software and as result of return losses versus frequency as shown in Figure 2 is obtained. The return loss has a minimum value of - 24.3758 db at frequency of 12.7978 GHz. VSWR Vs frequency plot is shown in Figure 3. VSWR has minimum value at frequency of 12.7978 GHz. So the resonant frequency of triangular microstrip antenna for these parameters is 12.7978GHz. So in this way a set of 60 input (‘s’, ‘h’ and ε).-output (f_r) pairs is created for the training set and another set of 16 input-output pairs (other than training pattern) for the testing the ANN. For Design of this antenna resonant frequency (f_r) , height of substrate (h) and dielectric constant (ε) are taken as input and side length as output parameter. Three dimensional plot of TMPA with specified dimensions is shown in Figure 4 which shows that gain of this antenna at resonant frequency of 12.7978 GHz is 4.59 dB. Reverse Process is done for analysis of TMPA. Side length (s) height of substrate (h) and dielectric constant (ε) are taken as input and resonant frequency (f_r) is taken as output parameter.

III. BUILDING ANN FOR DESIGN AND ANALYSIS OF TRIANGULAR MICROSTRIP ANTENNA AND RESULTS

The proposed technique uses feed-forward back-propagation artificial neural network (FFBP-ANN) with one hidden layer as an approximate model for designing and analysis of triangular microstrip patch antenna. ANN structures for the design and analysis triangular microstrip antenna are shown in Figure 5(a) and Figure 5(b) respectively. For the design of triangular microstrip ANN structure input layer has 3 neurons, hidden layer 5 neurons and output layer has only 1 neuron so 3-5-1 is best structure for the design of triangular microstrip antenna. Similarly for the analysis of triangular microstrip antenna 3-11-1 is best fit structure. The proposed both models for designing and analysis are trained Quasi-Newton algorithm. Learning Characteristic for both designing and analysis of triangular microstrip antenna are shown in Figure 6 and Figure 7 respectively. It is noted that total no. of 194 epochs are needed to reduce MSE level to a low value MSE 9.99664e-008/1e-007. Achievement of such a low value of performance goal (MSE) indicates that trained ANN model is an accurate model for designing the microstrip patch antennas. Similarly total no. of 51 epochs is needed to reduce MSE level to a low value MSE 9.66214e-008 for the analysis of antenna. The absolute errors at each value of side length for the design of triangular microstrip antenna are shown in Table 1. It is observed that maximum absolute value of absolute error between target data and estimated data for the design of triangular microstrip antenna is found to be only 0.00199980569912.Achievement of such low value of error further authenticates that the ANN model is accurate model for designing triangular microstrip antenna. Similarly maximum absolute value of absolute error between target data and estimated data for the calculating resonant frequency i.e. analysis of triangular microstrip antenna is found to be only 0.03317364437794.

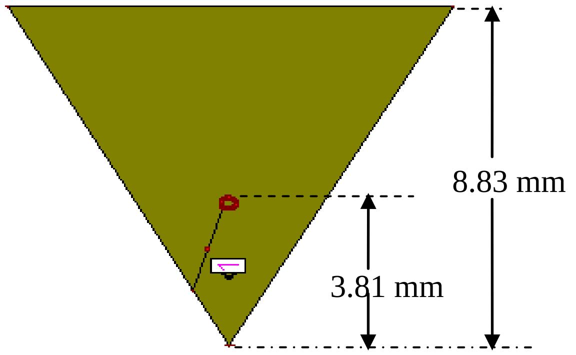


Fig.1 Triangular Microstrip Antenna

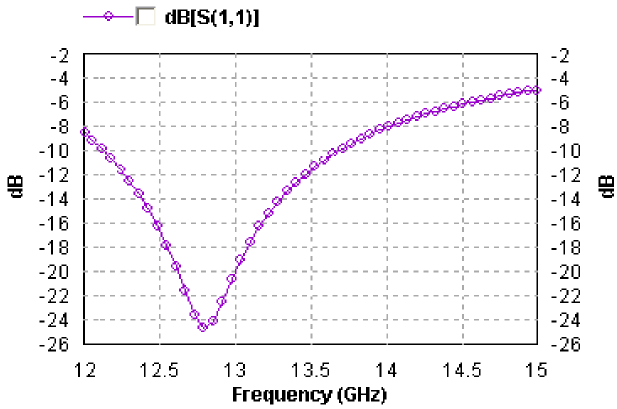


Fig. 2 Return losses Versus Frequency

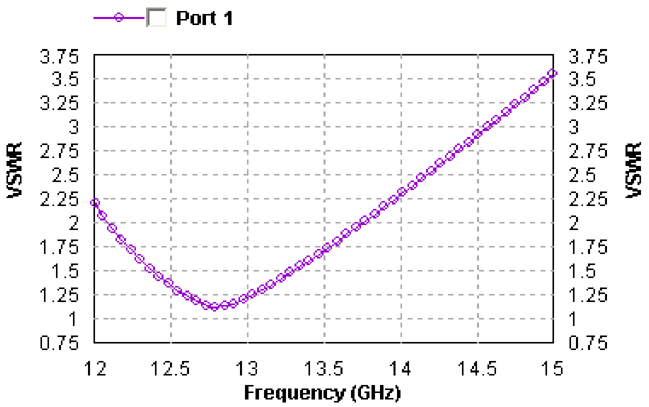


Fig.3 VSWR versus Frequency

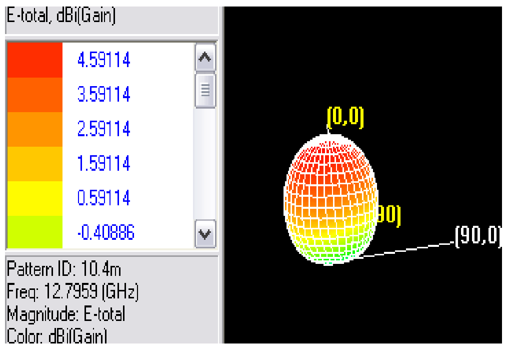
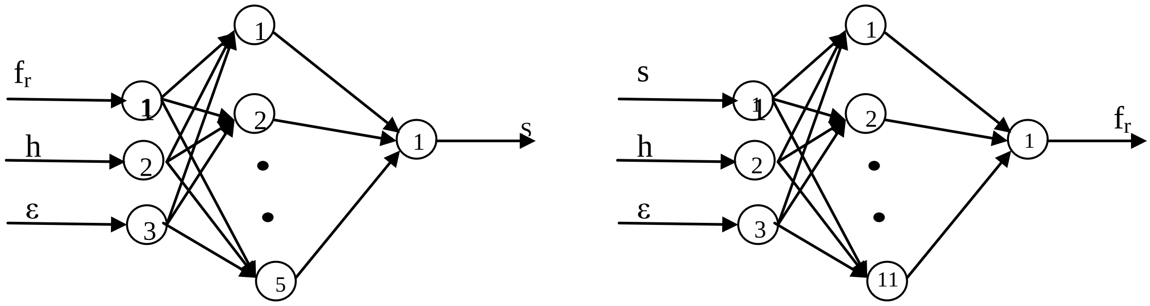


Fig. 4 True three dimensional Radiation pattern of triangular microstrip patch antenna with dBi (gain)



(a) (b)

Fig. 5 Neural Model for (a) design and (b) analysis of TMPA

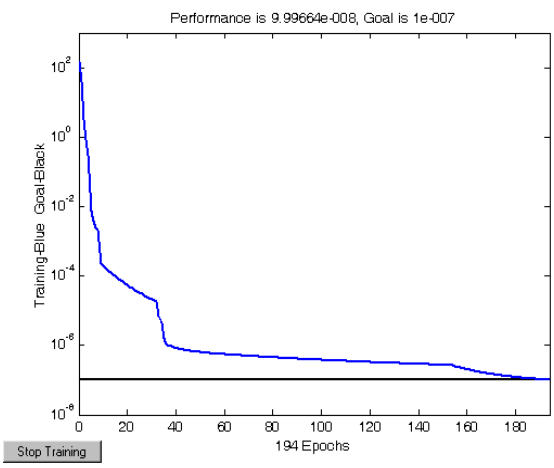


Fig.6 Learning Characteristic for design of antenna

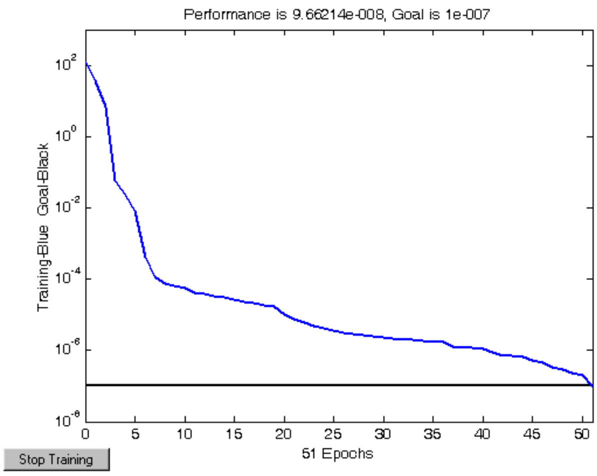


Fig.7 Learning Characteristic for analysis of antenna

Table 1 result of ann model for the design of triangular microstrip patch antenna

Dielectric Constant	Resonant frequency (IE3D Software)	Height of substrate	Side of Triangular Antenna (IE3D Software	Side of Triangular Antenna (ANN)	Absolute error
2.1	13.772	1.58	10	9.99994229177878	0.00005770822122
2.2	13.34	1.59	10.2	10.20005172672576	-0.00005172672576
2.3	12.7978	1.6	10.4	10.39979298063088	0.00020701936912
2.4	12.3764	1.61	10.6	10.59992700098692	0.00007299901308
2.5	11.9533	1.62	10.8	10.80133365111148	-0.00133365111147
2.6	11.5932	1.63	11	11.00002211325980	-0.00002211325980
2.7	11.2236	1.64	11.2	11.19993071169019	0.00006928830981
2.8	10.8709	1.65	11.4	11.39976808591835	0.00023191408165
2.9	10.535	1.66	11.6	11.59974873771668	0.00025126228332
3.0	10.2084	1.67	11.8	11.80050354234910	-0.00050354234910
3.1	9.9549	1.68	12	11.99800019430088	0.00199980569912
3.2	9.66563	1.69	12.2	12.19926045783251	0.00073954216749
3.3	9.3969	1.7	12.4	12.40031857987093	-0.00031857987093
3.4	9.1231	1.71	12.6	12.60181634543352	-0.00181634543352
3.5	8.8995	1.72	12.8	12.80025387065587	-0.00025387065586
3.6	8.61275	1.73	13	12.99976880251639	0.00023119748361

IV. CONCLUSIONS

In this paper feed-forward back-propagation artificial neural network (FFBP-ANN) with one hidden layer and trained with Quasi-Newton algorithm as an approximate model for the design of triangular microstrip patch antenna. The results of present study are quite promising. From the results, it is observed that the proposed modeling technique is very convenient to implement neural models for predicting the design parameters under specified conditions because an extremely small number of epochs are required to train the network. It has a wide possibility of applicability in the design of other types of antennas.

REFERENCES

[1] K.Siakavara , " Artificial Neural Network Employment in Design of multilayered microstrip antenna with specified frequency operation," *PIERS* online,Vol.3, No. 8,pp.1278-1282,2007.

[2] N. Turker, F. Gunes, T. Yildirim, "Artificial Neural Design of Microstrip Antennas," *Turk J Elec. Engin.*, vol.14, 2006.

[3] C. A. Balanis, *Antenna Theory*, John Wiley & Sons, Inc., 1997.

[4] A.P. Singh and J. Singh, "On the Design of a Rectangular Microsrip Antenna Using ANN, *"National Journal of the Institution of Engineers* (India) Vol.29, pp. 20-25July 2009.

[5] A. Mishra, G.B. Janvale, B.V. Pawar and P. M. Patil, "The Design of Circular Microstrip Patch Antenna by Using Quasi-Newton Algorithm of ANN," Journal of Electromagnetic Analysis & Applications, Vol.2, pp. 444-449, 2010.

[6] J.L. Narayan, S. Krishna, K. Reddy, "Design of microstrip antenna using artificial neural networks," *IEEE* Trans, Vol.1, pp 332-334, Dec 2007.

[7] A.P.Singh, J. Singh "On the design of a rectangular microsrip antenna using ANN," *Journal of the Institution of Engineers (India)* Vol.29, pp 20-25, July 2009.

[8] M.Naseer-Moghaddasi, P.D. Barjeoi, A. Nagesh, "A heuristic artificial neural network for analyzing and synthesizing rectangular microstrip antenna," *IJCSNS*, Vol 7, pp. 278-281, Dec. 2007.

[9] R.K. Mishra and A. Pattnyak, "Designing rectangular patch antenna using the Neurospectral method," *IEEE Trans. Antennas Propagation* .Vol. 51, pp 1914-1921, Aug 2003.

[10] S. A. Long and W. D. Walton, "A dual frequency stacked circular disc antenna," *IEEE Trans. Antenna and Propagation. AP*, pp. 270-273, 1979.

[11] J. Singh, A.P. Singh and T.S. Kamal "Design and analysis of circular microstrip patch antenna using ANN," proc. of *International Conference on Artificial Intelligence and Pattern Recognition (AIPR-10),* Orlando, FL, USA, pp. 214-218, July 12-14, 2010.

