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Effect of Varying the Substrates and Turns of a SR in the Design of Edge Chamfered Microstrip Patch Antenna through Artificial Neural Networks and Meta Resonators

R. Gayathri Rajaraman
Assistant Professor, Department of Electronics & Communication Engineering,
Annamalai University, Chidambaram, India

Abstract: In this paper, the design of size reduced patch antenna for various wireless applications using Artificial Neural Networks (ANN) is presented. Two Network; Cascade forward Back propagation and Feed forward Back Propagation Networks are Simulated, Trained and Tested to yield the optimized design of the Conventional Patch. The conventional patch is designed to resonate at 2.785 GHz with the aid of ANN and an FEM based simulator; while the proposed rectangular patch has triple resonances 1.78, 2.58, 2.87 GHz. The antenna is conveniently modified in to a Heptagon by chamfering one of its edges. Spiral resonator is effectively used in its ground plane to create miniaturization. The Antenna has a gain of 2.368, 2.706, 4.262 dBs respectively.

***Keywords*:** Rectangular microstrip patch antenna (RMPA), Slots, Miniaturisation, Linear Polarization, WLAN, WIMAX, DCS, ANN, FF, CF.

INTRODUCTION

Printed planar antennas finds enormous applications in almost all wireless communication devices due to many of its promising features. Deschamps proposed Rectangular Microstrip Patch Antenna (RMPA); is one such printed antenna. The design details and basic information about RMPA is seen in [2]. Neural method of optimizing is one of the emerging methods in antenna design. The algorithm used in this paper are seen in [3,4]. The design of antenna for dual resonance using SR is seen in [5].

Design of RMPA through ANN

RMPA is fed directly using Microstrip line as to create linear vertical polarization. Conventional Microstrip patch antenna is designed to resonate at 2.785 GHz using the design equations from [1]. Model I uses Rogers 3003 substrate which is assigned in layer one while A flexible RT Duroid substrate with ε_r of 2.2 and thickness of 60mils is used in layer 2 of this modeling. Model II has both the Layers of Flexible RT Duroid of thickness 120 mils. Two Neural models are simulated using Cascade Feed and Feed Forward. About Forty one Data are generated of which 90 % are used for Training and 10% of them are Tested. Of these two algorithms; it is found that Feed forward Back Propagation Network yield good result with A MSE of 0.000192. The Patch dimensions are given as Input to the Network while Frequency is predicted as Output from ANN. Figure 1 gives the simulated Neural networks (Both) with Regression Plot, Performance,Training States in it while Table1 gives Neural predicted Frequencies and Actual Frequencies. The Optimised Patch and its return Loss Characteristics are seen in Figure 2.

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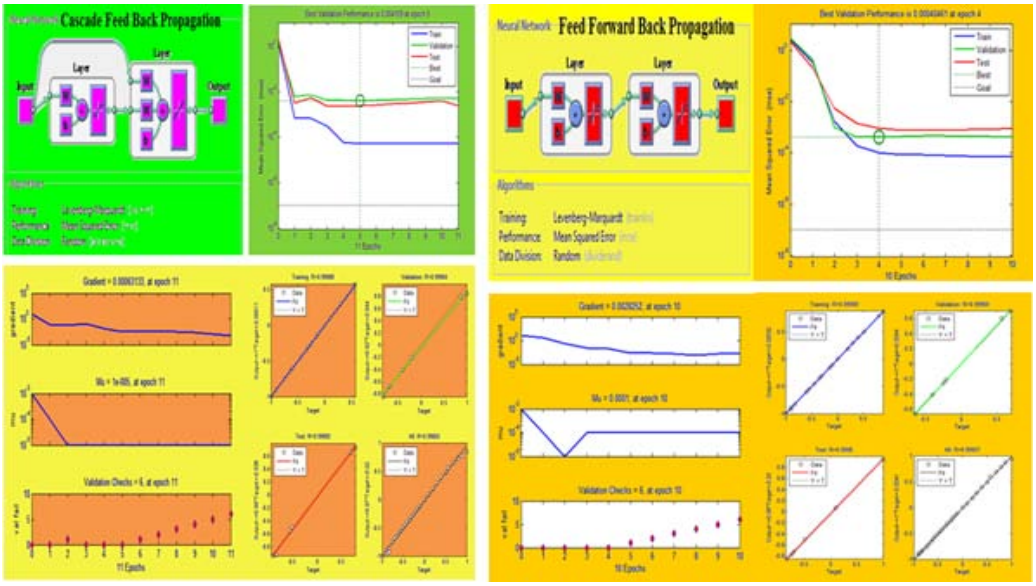
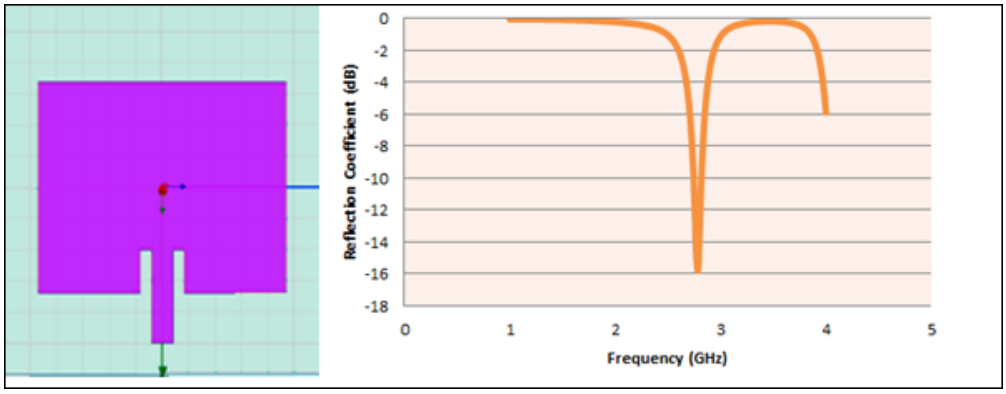


Fig. 1: ANN Both Algorithms



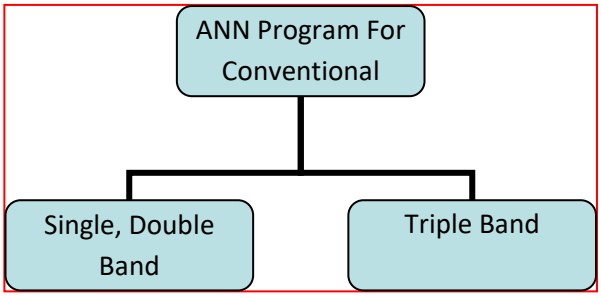
. ***Fig. 2:*** *Microstrip Patch Antenna Model its Return Loss Characteristics.*

Table 1: Actual, ANN Predicted frequency

Actual Frequency (GHz)	Predicted Frequency (GHz)
2.152100	2.160662
2.278300	2.275576
3.004900	3.012980
3.136100	3.135181
3.226800	3.255001
3.344100	3.371402
3.491100	3.485106
2.395100	2.393735
2.511900	2.515210
2.745600	2.764417
MSE	**0.000192**

Design of Wide Band, Dual, Triangular Bands of MPA

When substrate is changed in Layer 1 and number of turns are changed three different models Wide band, Dual Band, Tri Band antennas are effectively designed (Figures 4,5,6) and their results are shown in this section. Tables 2,3 gives optimized dimension and antenna parameters of the proposed three models.



. ***Fig. 3:*** *Design flow of the proposals Microstrip Patch Antenna Model*

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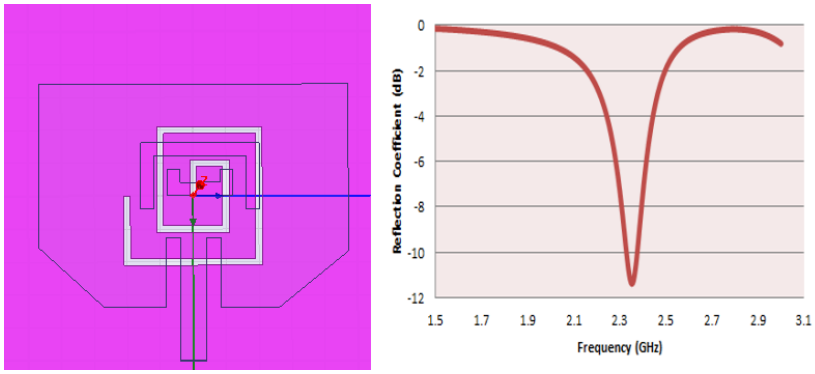

Fig. 4: *Proposed Antenna Model with U Slots on Patch and Spiral Etch on Ground (Top View) Single Resonance.*

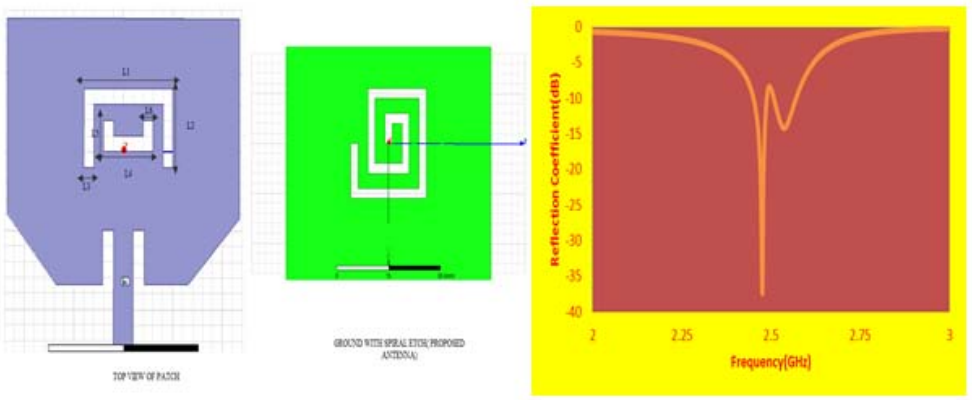

Fig. 5: *Proposed Antenna Model with U Slots on Patch and Spiral Etch on Ground (Top View).*

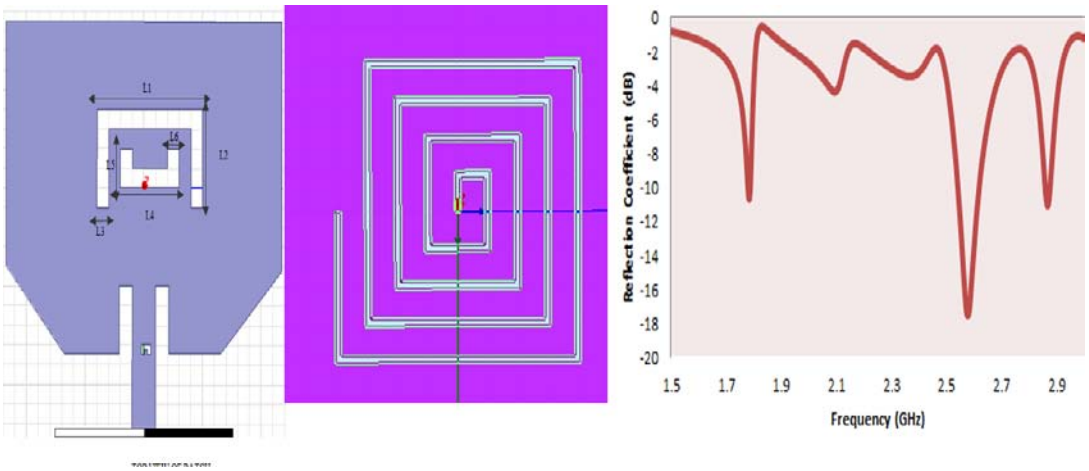

Fig.6: *Proposed Antenna Model with U Slots on Patch and Spiral Etch on Ground (Top View).*

Table 2: *Optimized Dimensions of the Proposed Patch Antenna.*

No.	Dimensions of Proposed MPA	Dual Band Value (mm)	Tri Band Value (mm)
1	Ground	0.55λ×0.55λ	0.55λ×0.55λ
2	Substrate	3.048	3.048
3	Patch	0.3942λ × 0.3197λ	0.3942λ × 0.3197λ
4	L1,L2,L3	18,10,2	18,10,2
5	L4,L5,L6	10,4,2	10,4,2
6	U shape slot on feed	1.5,1,0.5	1.5,1,0.5
7	Spiral turns	2	4
8	Width of spiral	2	1
9	Distance	5	5
10	Thickness of spiral	0.0025	0.0025

Table 3: Simulated Antenna Parameters *of the Proposed Antenna*

No.	**Antenna Parameter**	**2.356**	**2.476**	**2.54**	1.78	2.58	2.87
1	Max U	0.341	0.3035	0.36653	0.11606	0.14143	0.32293
2	Gain	4.29	4.528	5.0927	2.368	2.706	4.262
3	Radiation Efficiency	96.9%	98.056%	94.449%	95.79	91.3	99.3
4	Directivity	4.78	4.6146	5.392	2.472	2.9607	4.2991

****Red, Green, yellow color for single, dual resonance, color for triple resonances***

CONCLUSION

Three different models with a stage by stage improvement i.e. wide band single miniaturized, dual resonance, triple resonant antenna with a perturbed change is suggested. The conventional patch antenna is designed effectively and its dimensions are frozen with both Neural and EM simulation; the feed forward back Propagation converges fast than the other algorithm. By adjusting the dimensions of SR we get single, dual, triple resonance; similarly tetra band resonances may also be attempted; further directions may be for using Neural and fuzzy logic techniques for optimization besides simulator. Proposed Antenna supports linear vertical polarization**.**

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