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Fractal Tree Patch Antenna for Wireless Applications

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Abstract— **This paper presents a fractal tree patch antenna for multiband applications. The proposed antenna consists of scaled versions of circular patch with a square slot and rectangular connectors. The antenna has been printed on FR4 epoxy substrate with thickness 1.6mm and relative permittivity of 4.4. All simulations in this work were carried out by using the High Frequency Structure Simulator software (HFSS 13). The proposed antenna with fractals produces a penta-band operation for the S, C, X, Ku and K band applications.**

Index Terms— **Circular patch, Fractal, Multiband.**

I. Introduction

Wireless communication is one of the tremendous areas in the communication field. To accommodate different standards in wireless communication we need to design multiband antenna. The patch antenna is mostly used in communication systems because of its various advantages such as simple design, high efficiency, low profile and low fabrication cost. The main drawback of early patch antenna designs includes the relatively large size and the narrow bandwidth. Different designs have been developed to overcome the inadequacy in the characteristics of patch antennas and the limitation lies in the design of compact antennas for UWB applications [1]-[5].

The fractal nature of the antenna shrinks its size, without the use of any components such as capacitors, inductors and diodes. This makes the fractal antenna a first-class design for wideband and multiband applications. The key feature of the fractal antennas is the repetition of their motif over two or more iterations. The fractal antennas are very compact, multiband or wideband, and have useful applications in cellular and microwave communications.

Nowadays a lot of fractal antennas are introduced with different shapes [6]-[9]. A pentagonal shape with Koch fractal etched inside the patch is developed in [10]. A hexagonal fractal antenna for UWB and multiband operation is introduced in [11].

This paper presents a tree structured fractal antenna for multiband applications. The antenna offers good performance in five different frequency bands (3.35–7.47 GHz, 9.28–11.84 GHz, 12.78–14.35 GHz, 14.7–16.52 GHz and 18.3–25 GHz) and is suitable for military, radar, satellite applications. Section II presents the details of the antenna design. Section III discusses simulations and optimizations of performance of the antenna. The results are discussed in section IV. Conclusion is summarized in Section V.

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II. Antenna Design

The geometrical construction of the fractal tree starts with a circular patch with a square slot. Figure 1 shows the base shape of the proposed fractal geometry.

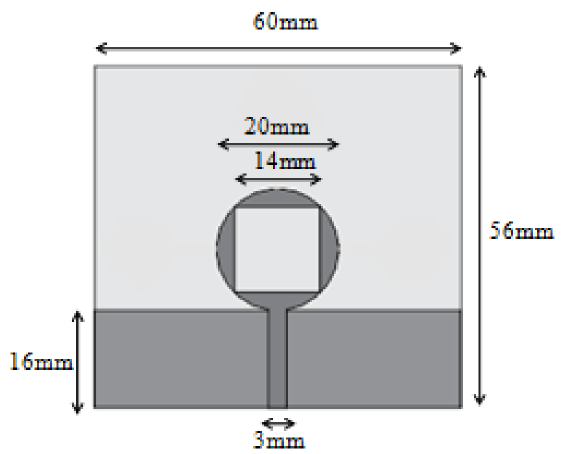

Figure 1 Base shape

The penta-band fractal tree antenna presented here consists of a partial ground plane and 50-Ω microstrip feed line and is printed on the FR4 epoxy substrate of relative permittivity 4.4 and loss tangent tan δ= 0.02 with thickness of h =1.6mm. The proposed antenna is designed by scaling the base structure and arranging it outside the base structure as shown in Figure 2.

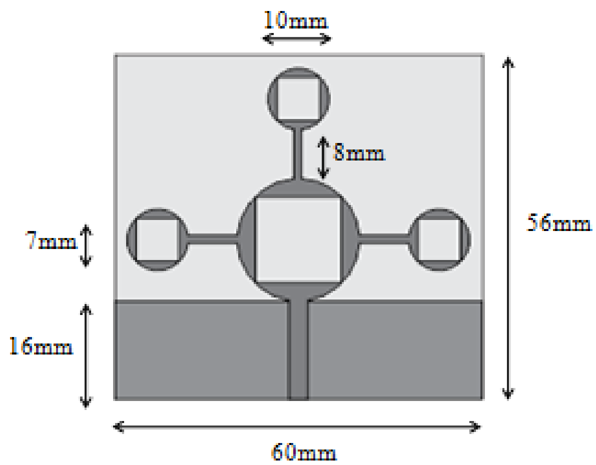

Figure 2 Proposed antenna structure

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III. Simulations and Optimizations

The performance of the antenna and determination of the parameters was analyzed by simulating using High Frequency Structure Simulator software. Return loss characteristics of designed antenna for different iteration stages are depicted in Figure.3.

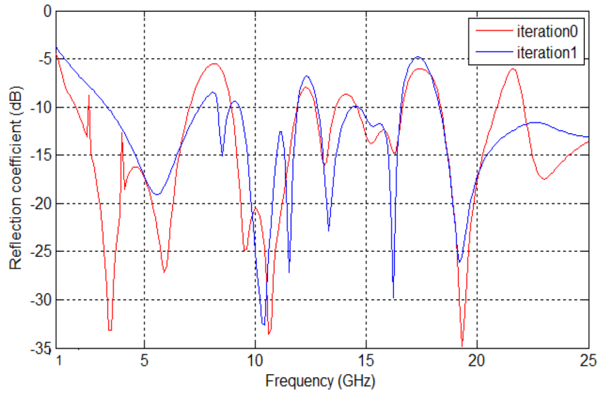

Figure 3 Return loss of proposed antenna structure for various iterations

The further iterations are not considered since the antenna size will increase with the iterations.

The antenna was simulated on different substrates having different dielectric constant and thickness and the results are illustrated in Figure 4.

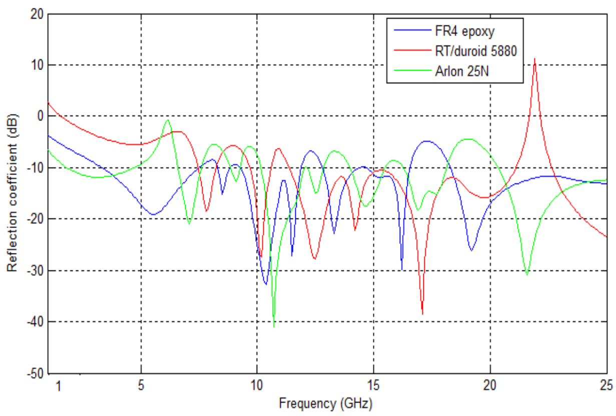

Figure 4 Return loss of proposed antenna on different substrates

IV. Results

The designed penta-band antenna has the capability to operate on various frequency bands. Figure 5 shows the resulting antenna return loss response. From the results the measured bandwidths are from 3.35–7.47 GHz, 9.28–11.84 GHz, 12.78–14.35 GHz, 14.7–16.52 GHz, and 18.3–25 GHz for S11 ≤ -10dB which corresponds to VSWR < 2.

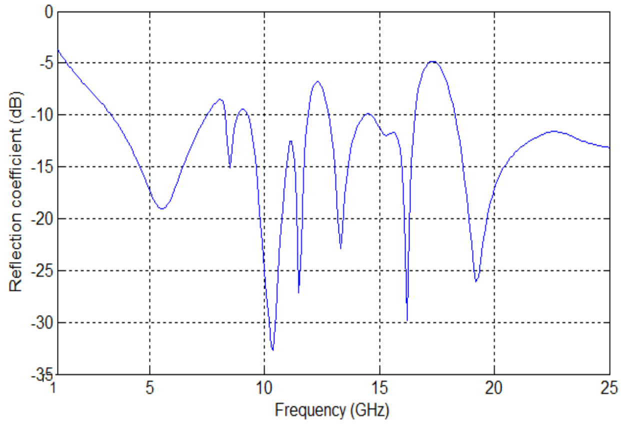

Figure 5 Return loss of proposed antenna

The simulated VSWR of the proposed antenna is shown in Figure 6 which satisfies the values of proposed antenna.

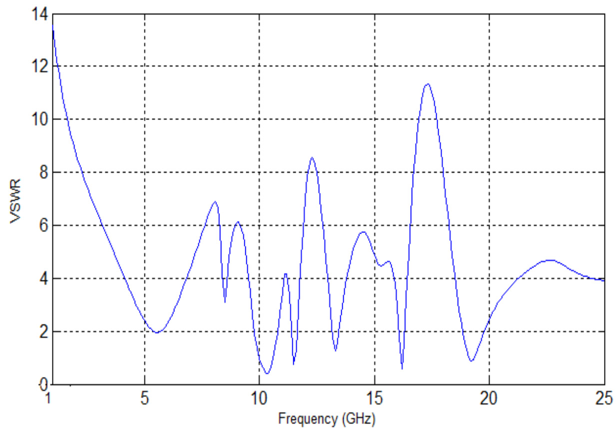

Figure 6 VSWR of proposed antenna

The antenna characteristics are tabulated in Table 1.

Table 1 Characteristics of the proposed antenna

Resonant Frequency(GHz)	*Return Loss (dB)*	*Bandwidth (MHz)*
5.5	-19.06	4120
10.3	-32.50	2560
13.2	-22.52	1570
16.2	-29.77	1820
19.1	-25.98	6700

The radiation patterns of proposed antenna in the E and the H planes measured at different frequencies are shown in Figure 7. The designed penta-band antenna has similar radiation patterns for different frequencies of operation.

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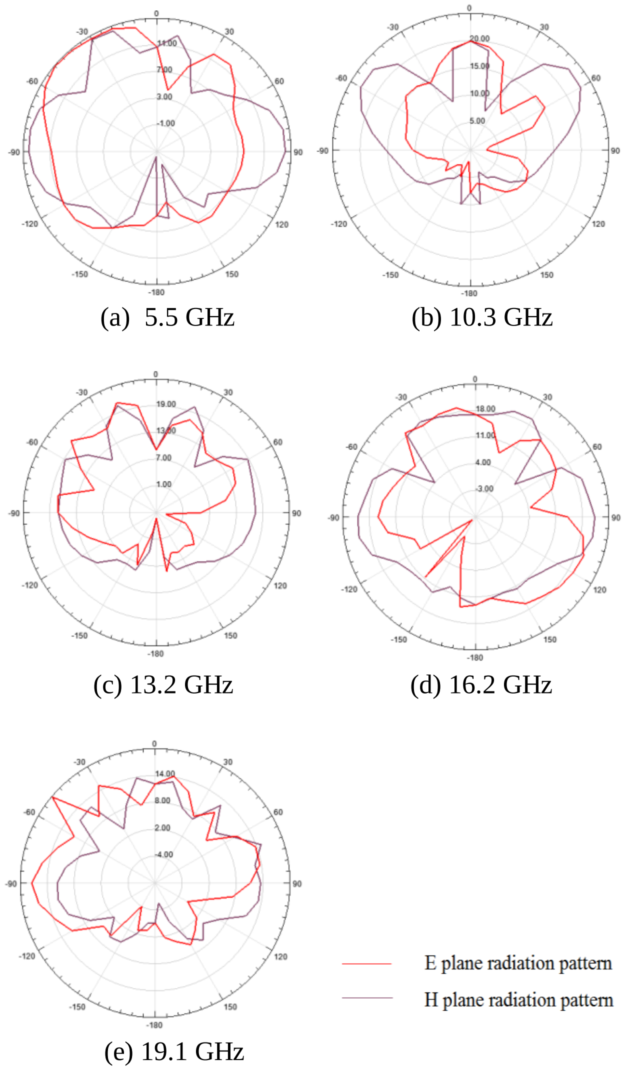

Figure 7 Radiation pattern of proposed antenna at different frequencies

The comparison of the designed antenna with some of the previously reported multiband antennas are shown in Table 2, from the comparison the proposed antenna is found to be compact and simple in design.

Table 2 Comparison between recently reported antennas and the proposed antenna

Antenna	*Number of operating bands*	*Antenna Size (mm^3)*
Proposed antenna	5	60×56×1.6
[6]	5	62×89.6×0.78
[7]	3	59×90×1.6
[8]	5	110×90×1.6
[9]	6	80×54×1.6

V. CONCLUSION

This paper presents the microstrip line fed fractal antenna for wireless applications. Antenna parameters such as return loss, VSWR and radiation patterns are observed and analyzed. On analyzing the simulated results it shows that the proposed antenna exhibits good performance in five different bands 3.35 – 7.47 GHz, 9.28 – 11.84 GHz, 12.78 – 14.35 GHz, 14.7 – 16.52 GHz and 18.3 – 25 GHz which makes it is suitable for various wireless frequency bands of different applications.

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REFERENCES

[1] Jianxin Liang, Choo C. Chio, Xiaodong Chen, Clive G.Parini, "Study of Printed Circular Disc Monopole Antenna for UWB systems", IEEE Transactions on Antennas and Propagation, vol.53, pp.3500-3504, November 2005.

[2] K.P. Ray and Y.Ranga, “Ultrawideband Printed Elliptical Monopole Antennas”, IEEE Transactions on Antennas and Propagation, vol. 55, pp.1189-1192, April 2007.

[3] L. Dang, Z. Y. Lei, Y. J. Xie, G. L. Ning, and J. Fan, “A compact microstrip slot triple-band antenna for WLAN/WiMAX applications,” IEEE Antennas and Wireless Propagation Letters, vol. 9, pp. 1178–1181, 2010.

[4] Wen-quan Cao , Qian-qian Wang, Bang-ning Zhang, Wei Hong, “Capacitive probe-fed compact dual-band dualmode dual-polarisation microstrip antenna with broadened bandwidth”, IET Microwaves, Antennas & Propagation, vol.11, pp.1003-1008,2017.

[5] W. Hu, Y.-Z. Yin, P. Fei, and X. Yang, “Compact triband square-slot antenna with symmetrical L-strips for WLAN/WiMAX applications,” IEEE Antennas and Wireless Propagation Letters, vol. 10, pp. 462–465, 2011.

[6] R. S. Aziz, M. A. S. Alkanhal, and A. F. A. Sheta, “Multiband fractal-like antennas”, Progress In Electromagnetics Research B, vol. 29,pp. 339-354, 2011.

[7] Mahatthanajatuphat, C., Saleekaw, S. and Akkaraekthalin, P, “A Rhombic Patch Monopole Antenna with Modified Minkowski Fractal Geometry for UMTS, WLAN and Mobile WiMAX Applications”,Progress in Electromagnetic, vol.89, pp.57-74, 2009.

[8] El-Khamy SE, Zaki A, Hamdy S, El-Khouly A, “ A new fractal-like tree structure of circular patch antennas for UWB and 5G multi-band applications” , Microw Opt Technol Lett., 59, pp.2168–2174,2017.

[9] Zhen Yu, Jianguo Yu, Xiaoying Ran,Chenhua Zhu, “A novel Koch and Sierpinski combined fractal antenna for 2G/3G/4G/5G/WLAN/ navigation applications”, Microw Opt Technol Letters,vol.59,pp.2147–2155,2017.

[10] Khan, O.M., Islam, Z.U., Farooq, I.R., Bhatti, A. and Islam, Q.U, “Novel Miniaturized Koch Pentagonal Fractal Antenna for Multiband Wireless Applications”, Progress in Electromagnetic Research, vol.141, pp.693-710,2013.

[11] Azari, A. and Rowhani, J, “Ultra Wide Band Fractal Microstrip Antenna Design”, Progress in ElectromagneticResearch C, vol.2, pp.7-12,2008.

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