Deepal Gupta al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 2, Issue 1, March 2015, pp. 104-106

Sierpinski Carpet based Fractal Antenna for Wimax Frequencies

Deepal Gupta[1], Prof. Umesh Barahadiya[2]

[1,2]Electronics and Communication Engineering, Nagaji Institute of Technology and Management Gwalior, India

***Abstract*— In this paper, a novel Sierpinski carpet based fractal antenna for Wimax frequencies for three iterations, is proposed. The given antenna is composed of a rectangular patch antenna loaded with rhombus structures. The antenna is designed for resonating between 2-6 GHz frequency range for Wimax application. The proposed antenna is simulated on CST version 10 and the results are in good agreement. The 50 ohm port is used to feed the proposed antenna.**

***Keywords*— Fractal, Wimax, Sierpinski Carpet Fractal Antenna, Micro-strip antenna.**

I. Introduction

Concept of antenna has been around for a long time, millions of years, as the organ of touch or feeling of animal, birds and insects. But in the last 100 years they have acquired a new significance as the connection link between a radio system and the outside World. The first radio Antenna was built by Heinrich Hertz, a professor at the Technical Institute in Karlsruhe, Germany. The IEEE standard defines an antenna as a part of a transmitting or receiving system that is designed to radiate or to receive electromagnetic waves [1]. A patch antenna [2–3] is a low-profile antenna consisting of a metal layer over a dielectric substrate and ground plane. Typically, a patch antenna is fed by a micro-strip transmission line, but other feed lines such as coaxial can be used. The advantages of patch antennas are that they radiate with moderately high gain in a direction perpendicular to the substrate and can be fabricated in a low cost FR-4 substrate. Micro-strip antennas have unique features and attractive properties such as low profile, light weight, compactness and Conformability in structure [4]. With those advantages, the antennas can be easily fabricated and integrated in solid-state devices. Micro-strip antennas are widely applied in radio frequency devices with single-ended signal operation. In modern wireless communication systems, the micro-strip patch antennas are commonly used in the wireless devices. Therefore, the miniaturization of the antenna has become an important issue in reducing the volume of entire communication system [6]. Further the tremendous increase in wireless communication in the last few decades has led to the need of larger bandwidth and low profile antennas for both commercial and military applications. One technique to construct a multiband antenna is by applying fractal shape into antenna geometry.

II. ANTENNA DESIGN THEORY

The designing parameters [10, 11] of rectangular micro-strip patch antenna are L=28.50mm, W=36.00 mm, length of transmission line feed=35.82175 mm, with width of the feed=3.009 mm. The rectangular micro-strip patch antenna is designed on FR-4 (Loss free) substrate with permittivity of 4.3 and height from the ground plane is 1.6 mm. A novel printed fractal antenna is composed of a rectangular patch printed antenna over the FR4 substrate loaded with a rhombus shaped structure filled with another rhombus having smaller in area, treated as a base fraction. The rhombic structure is positioned at the center of the micro-strip patch antenna for first iterations. For the second iteration, base fraction will be constantly positioned and sierpinski carpet is designed around this base fraction that will be considered as a second iteration. During third iteration, the sierpinski carpet will be again designed around the every sub structures of the second iteration.

The RMPA parameters are calculated from the following formulas [11-12].

Calculation of Width (W):

Where C = free space velocity of light, ε_r

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$$

=Dielectric constant of substrate.

The effective dielectric constant of the rectangular micro-strip patch antenna:

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right)$$

Actual length of the patch (L):

L = Leff - 2ΔL

Where

$$\text{Leff} = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}}$$

Calculation of length extension:

Fig.1, 2, 3 shows the structure of the first, second and third iteration of the proposed antenna respectively and the Table. I show the parameters of the 1st iteration of proposed antenna. The antenna is modeled and simulated using method of moment based electromagnetic simulation software CST, version 10, between 2 to 6GHz. The shape and size of the structures used in 2nd and 3rd iteration are of 1/3 of the basic fraction.

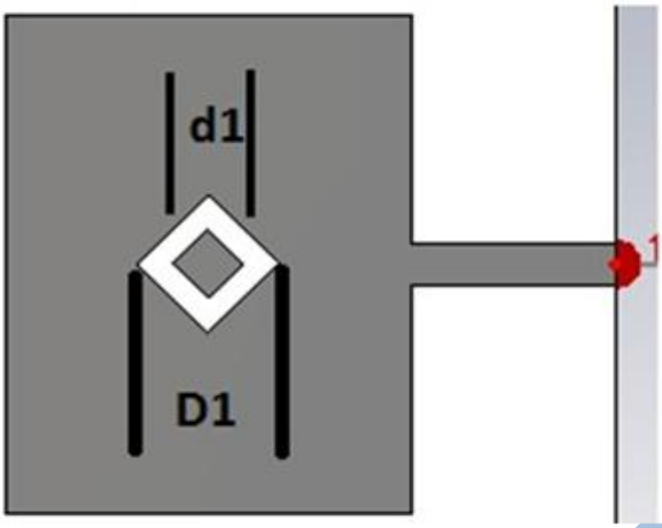

Figure 1: Structure of 1st iteration of proposed antenna.

TABLE.I: STRUCTURAL PARAMETERS OF 1st ITERATION

Sr. No.	**Parameters of 1st iteration proposed antenna**		
	Parameters	***Dimension***	***Unit***
1.	D1	10.00	mm
2.	d1	05.00	mm

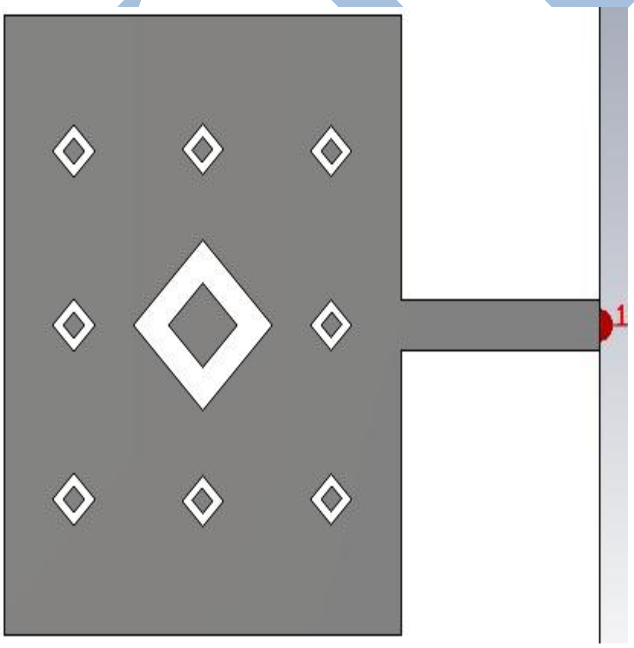

Figure 2: Structure of 2nd iteration of proposed antenna

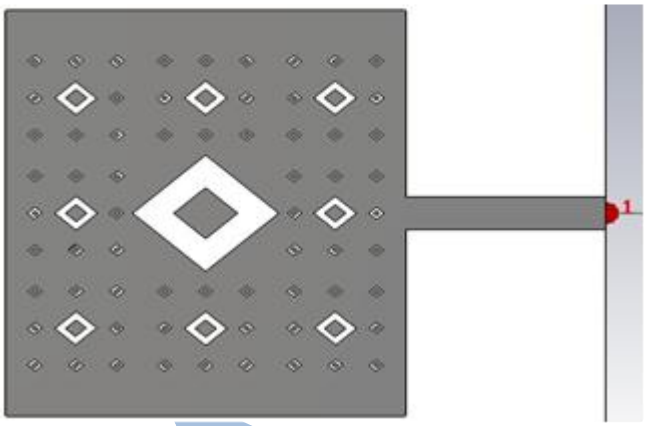

Figure 3: Structure of 3rd iteration of proposed antenna

III. SIMULATION RESULTS

Fig. 4, 5 and 6 shows the graph of return loss V/s frequency for 1st, 2nd and 3rd iteration respectively. The graph of return loss shows that antenna is resonating as a multiband between 2 to 6 GHz frequencies.

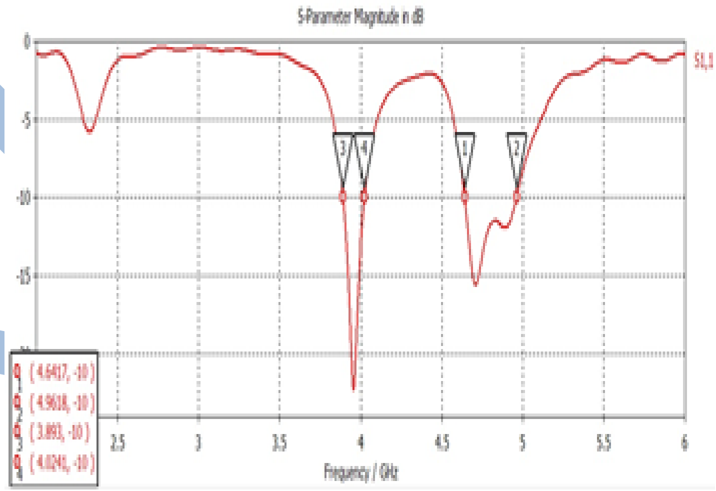

Figure 4: Return Loss V/s Frequency for 1st iteration.

In figure 4, the antenna is resonating at 3.956 GHz with a bandwidth of 131.1 MHz and also shows an another band of 320.1 MHz

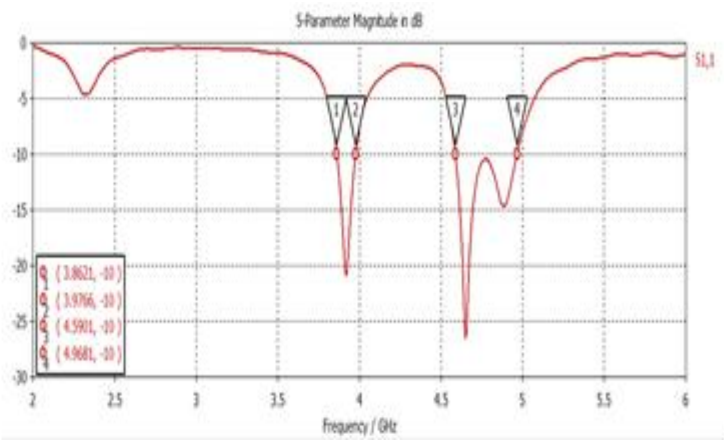

Figure 5: Return Loss V/s Frequency for 2nd iteration.

In figure 6, however the first band is reduced upto 114.5 MHz but second band has been extended upto 378 MHz.

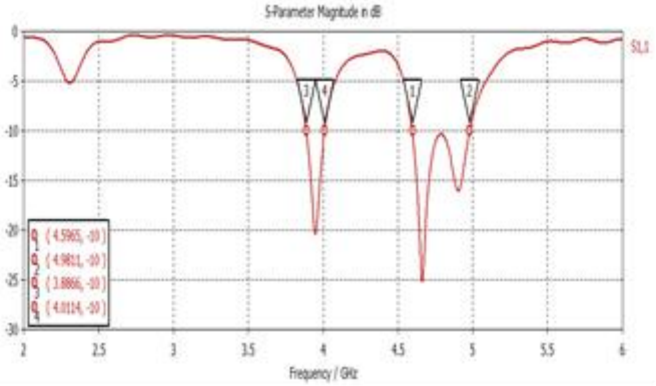

Figure 6: Return Loss V/s Frequency for 3rd iteration.

In figure 6, the first band is increased upto 124.8 MHz while second band has been again improved upto 384.6 MHz bandwidth.

IV. CONCLUSION

A sierpinski carpet fractal antenna between 2 to 6 GHz frequencies is analyzed for Wimax applications. The antenna is modeled on low cost and easily available FR4 substrate. Each iteration is an improved version of the previous one. Bandwidth of the first band can be improved by using some different structures or techniques

V. REFERENCES

[1]. C.A. Balanis, Antenna Theory and Design, John Wiley & Sons, 1997.

[2]. W. L. Chen and G. M. Wang, “Small size edge fed Sierpinski Carpet Microstrip Patch Antennas”, Progress In Electromagnetics Research, vol. 17, (2008), pp. 95-107.

[3]. D. H. Werner and S. Ganguly, “An overview of fractal antenna engineering research”, IEEE Antennas and Propagation Magazine, vol. 45, no. 1, (2003), pp. 38-57.

[4]. S. N. Khan, J. Hu, J. Xiong and S. He, “Circular fractal monopole antenna for low VSWR UWB applications”, Progress in Electromagnetics Research Letters, vol. 1, (2008), pp. 19-25.

[5]. P. kaur, “A reconfigurable square ring slot antenna for operation in GSM and WLAN frequency bands”, International journal of microwave and optical technology, vol. 7, no. 1, (2012) January, pp. 49-54.

[6]. Y. Zhang, B. Z. Wang, X. S. Yang and W. Wu, “A fractal Hilbert microstrip antenna with reconfigurable radiation patterns”, Proceedings of IEEE Antennas and Propagation Society International Symposium (APS-URSI 2005), ,Washington DC, USA, (2005) July, pp. 254–257.

[7]. B. Mirzapour and H. R. Hassani, “Size reduction and bandwidth enhancement of snowflake fractal antenna”, IET Microwaves, Antennas& Propagation, vol. 2, (2008) March, pp.180-187.

[8]. A. Sundaram, M. Maddela and R. Ramadoss, “Koch-Fractal Folded-S.lot Antenna Characteristics”, IEEE Antennas and Wireless Propagation Letters, vol. 6, (2007), pp.219-222.

[9]. J. Vemagiri, M. Balachandran, M. Agarwal, et al., “Development of compact half-Sierpinski fractal antenna for RFID applications”, Electronics Letters, vol. 43, no. 22, (2007) October 25.

[10]. N. Kingsley, D. E. Anagnostou, M. Tentzeris and J. Papapolymerou, “RF MEMS Sequentially Reconfigurable Sierpinski Antenna on a Flexible Organic Substrate With Novel DC-Biasing Technique”, Microelectromechanical Systems, vol. 16, (2007) October, pp. 1185-1192.

[11]. K. C. Hwang, “A Modified Sierpinski Fractal Antenna for Multiband Application”, Antennas and Wireless Propagation Letters, IEEE, vol. 6, (2007), pp. 357-360.

[12]. D. H. Werner and S. Ganguly, “An Overview of Fractal Antenna Engineering Research”, IEEE Antenna and wave Propagation Magazine, vol. 45, no. 1, (2003) February.

[13]. D.D. Krishna, M. Gopikrishna, C.K. Aanandan, P. Mohanan, and K. Vasudevan, “ Compact wideband Koac Fractal Printed slot antenna.” IET Micro waves, Antennas and Propagation, Vol3, No. 5, pp. 782-789, 2009.

[14]. B.L. Ooi, “A modified contour integral analysis for Sierpinski fractal carpet antennas with and without electromagnetic band gap ground plane,” IEEE Trans. Antennas Propag., Vol.52, pp. 1286-1293, May 2004.

[15]. Vinoy, K. J., “Fractal shaped antenna elements for wide and multi-band wireless applications,” Thesis, Pennsylvania, Aug. 2002.

[16]. N. A. Saidatul, A. A. H. Azremi, R. B. Ahmad, P. J. Soh, and F. Malek, "Multiband fractal planar inverted F antenna (F-PIFA) for mobile phone application," Progress in lectromagnetic Research (PIER), vol. 14, pp. 127-148, 2009.

[17]. P. J. Soh, G. A. E. Vandenbosch, S. L. Ooi, and M. R. N. Husna, "Wearable dual-band Sierpinski fractal PIFA using conductive fabric," Electronics Letters, vol. 47, pp. 365-367, 2011.

[18]. S. N. Shafie, I. Adam, and P. J. Soh, "Design and Simulation of a Modified Minkowski Fractal Antenna for Tri-Band Application," in Mathematical/Analytical Modelling and Computer Simulation (AMS), 2010 Fourth Asia International Conference on, 2010, pp. 567-570.

[19]. Yogesh Kumar Choukiker, S.K. Behera, “Design of Wideband Fractal Antenna with Combination of Fractal Geometries.” ICICS, 2011.

