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Design of Fractal Antenna for ISM band Application

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Abstract: Emerging wireless communication antennas presently need to operate at ISM. In this paper, a Cantor fractal monopole antenna using multi fractal structure is proposed and presented for ISM band applications. The antenna is designed in FR4 substrate with dielectric constant of 4.6. Simulation is performed with CST microwave studio. The bandwidth of the antenna is optimized and the gain of the proposed antenna is improved.

Keywords: Cantor, fractal antenna, ISM band, multifractal.

I. INTRODUCTION

Nowadays, antenna with good characteristics, low cost and small size is an important component and plays a vital role in wireless communications [1]. Besides exploiting the frequency band of 3.1 - 10.6 GHz for a ultra wideband applications, the users of wireless communications technology are eagerly searching for the super wide band antenna (SWB) is used to cover both the short and long range transmission for ubiquitous applications [4].

SWB technology is becoming more unique when compare to many potential applications due to larger channel capacity, the high time precision etc. The antenna with the bandwidth ratio larger than 10:1 for impedance bandwidth at 10 dB return loss is called super wideband [6].

Different techniques and methods have already been proposed to achieve for operating super wide band. In the recent years, there has been an increasing amount of literature on SWB antenna [9]. For example a compact semi-elliptical patch antenna fed by a tapered coplanar waveguide was designed in [10]. With a measured bandwidth ratio of 19:70:1, the proposed antenna is suitable to operate within frequencies of 0.46 GHz to 9.07 GHz. In [8], a half circular antipodal slot antenna with a range of super wideband frequencies between 0.8 GHz to 7 GHz was presented.

A planar asymmetrical dipole antenna of circular shape was proposed in [7]. With a dimension of 90 mm £ 135 mm, the proposed antenna achieved an operating bandwidth ranging from 0.79 to 17.46 GHz. An asymmetrical super-wideband dipole antenna is implemented in [10]. A novel SWB antenna that achieved a frequency band between 5 GHz to 150 GHz is proposed. Despite of huge bandwidth it is not suitable for lower frequency bands such as WiMAX and S band.

Communication. In [2], a compact super wideband monopole antenna with switchable dual band-notched characteristics was proposed for 3 to 33 GHz band. However, the performance of this antenna was not validating experimentally. An extremely wideband monopole antenna for triple-band notched characteristics was proposed [5]. With a size of 150 mm £ 150 mm, the designed antenna achieved a bandwidth ranging from 0.7225 GHz with three notch band for WLAN and X-band. In [3], an monopole antenna with super-wideband was designed. However, it's three dimensional structure makes it difficult to integrated into devices. Besides, the antennas proposed in do not cover K-band which opens a new arena to design an antenna that covers various band such as S, C, X, Ku, K and Ka bands.

Other than the monopole antennas, one of the methods to achieve SWB is the multifractal geometry. The self similarity and space are two common important properties of fractal geometry. The self similarity leading to wide band while space increases the electrical length [11]. In [12], a super wide band fractal antenna has been modeled and simulated for super wideband application. By using a normal square loop, the antenna can achieved a super wide frequency band ranging from 20 GHz to 60 GHz. However its performance has not been validated experimentally and it is not used for microstrip technology.

In this paper, fractal antenna based on cantor multifractal geometry is proposed. The iterations of a cantor multifractal with a transmission line helps to achieve wide impedance bandwidth. The symmetric radiation patterns and stable gain make the proposed antenna is used for various wireless applications such as ISM (2400-2483 MHz), Wi-Fi (2400 MHz), Bluetooth (2400-2500 MHz), WLAN (2.4-2.48 GHz) .

II. METHODOLOGY

Customization of Multiracial Cantor antenna for given specification. The emerging wireless antenna needs to operate at ISM band. In order to meet the above requirement, the antenna structure has to be optimized. This is done by varying the values of IFS probabilities p_1 and p_2 corresponding to the dimension of the fingers of third iterated Cantor multifractal structure.

Using the equation

$$f_n \approx \frac{c \times 0.24}{\sqrt{\varepsilon_r}}\left[\frac{1}{L+r+p}\right]$$

And multifractal IFS coefficients, the physical parameters are obtained as follows. The resultant geometry of the optimized multifractal antenna is shown in Figure 1.

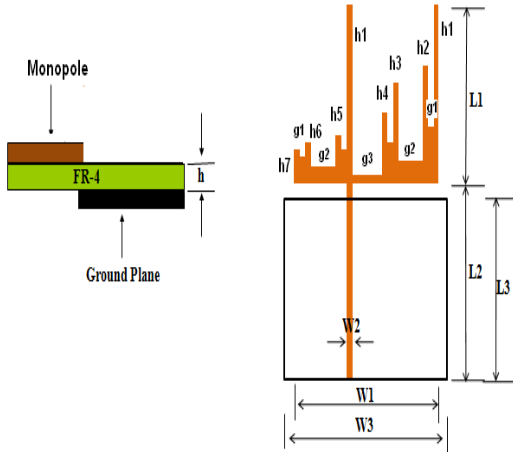

Fig: 1 Multi fractal Cantor antenna (a) Cross sectional View (b) Top View

The performance of the multifractal Cantor antenna has been investigated using CST Microwave Studio.

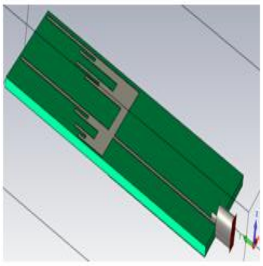

Fig: 2 Layout Diagram for Multi fractal Cantor antenna

The fractal monopole is etched on a FR4 substrate (thickness=1.6mm, εr=4.6, tan δ=0.025). The vertical height of the monopole fractal antenna is 41.5mm and the Dimension of ground plane is 32.11mm and 41.782mm.

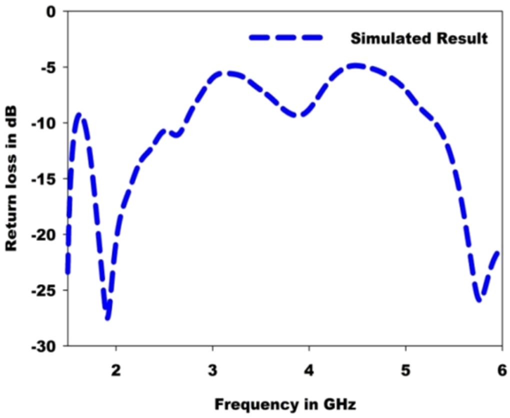

Fig: 3 simulated return loss (S_{11}) of a Multi fractal Cantor antenna

The simulated return loss of the proposed antenna are in good agreement as depicted in Fig. 3. The dimension of the finger and the coupling between the fingers generate the other resonant modes. The center frequency of each band appears in the second column, bandwidth in the third column and the frequency ratio between the adjacent bands is depicted in the fourth column.

The simulated of both and components of the electric field at the principal plane cuts (Z-X plane and X-Yplane) for the resonant frequencies 2.4 and 5.8GHz is shown in Fig.4. Values are normalized with respect to maximum total electric field and expressed in decibels. The radiation patterns are found to be omni directional in X-Y plane with better cross polar level at all resonating bands of operation.

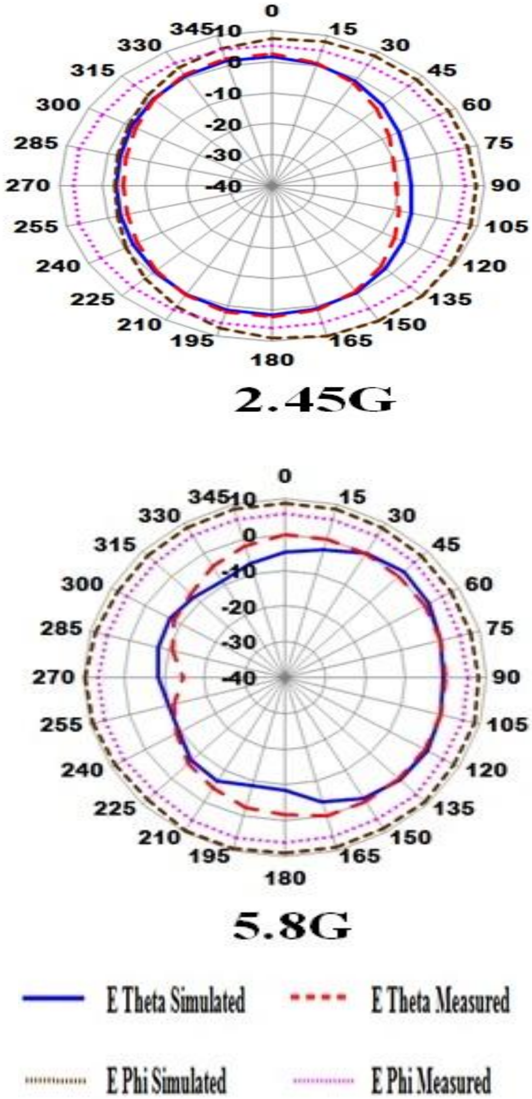

Fig: 4. The Simulated radiation patterns of third iterated multifractal Cantor antenna at 2.4 GHz, and 5.8 GHz, respectively. (Z-X plane and X-Y plane polarization comparison) where θ and φ are standard polar coordinates.

III. CONCLUSION

A novel printed Multifractal Cantor monopole antenna using multifractal technique has been proposed. The antenna has ISM band characteristics covering Bluetooth and WLAN applications. The use of multifractal concept in the Cantor based fractal antenna design made it flexible in terms of controlling bandwidth.

REFERENCES

[1] I. Zahraoui, J. Terhzaz, A. Errkik, El. H. Asbdelmounim, A. Tajmouati, L. Abdellaoui, N. Ababssi, M. Latrach “Design and Analysis of a New Dual-Band Microstrip Fractal Antenna,” Vol:9, No:1, 2015

[2] Ghatak, R., A. Karmakar, and D. R. Poddar, “Hexagonal boundary Sierpinski carpet fractal shaped compact ultrawideband antenna with band rejection functionality," International Journal of Electronics and Communications,” Vol. 67, No. 3, 250-255, 2013.

[3] Sievenpiper, D. F., D. C. Dawson, M. M. Jacob, T. Kanar, K. Sanghoon, J. Long, and R. G. Quarfoth, “Experimental validation of performance limits and design guidelines for small antennas," IEEE Transactions on Antennas and Propagation, Vol. 60, No. 1, 8-19, 2012.

[4] Chen, K. R., C. Y. D. Sim, and J. S. Row, “A compact monopole antenna for super wideband applications," IEEE Antennas and Wireless Propagation Letters, Vol. 10, 488-491, 2011.

[5] Azari, A., “A new super wideband fractal microstrip antenna," IEEE Transactions on Antennas and Propagation, Vol. 59, No. 5, 1724-1727, 2011.

[6] Tran, D., P. Aubry, A. Szilagyi, I. E. Lager, O. Yarovyi, and L. P. Ligthart, “On the design of a super wideband antenna," 399-426, Ultra Wideband, Boris Lembrikov (ed.), InTech Publication, 2011, ISBN: 978-953-307-139-8.

[7] Barbarino, S. and F. Consoli, “Study on super-wideband planar asymmetrical dipole antennas of circular shape," IEEE Transactions on Antennas and Propagation, Vol. 58, No. 12, 4074-4078, 2010.

[8] Lu, W. and H. Zhu, Super-wideband antipodal slot antenna," Proceedings of the Asia Pacific Microwave Conference,” 1894-1897, Singapore, 2009.

[9] Lau, K. L., K. C. Kong, and K. M. Luk, “Super-wideband monopolar patch antenna," Electronics Letters,” Vol. 44, No. 12, 716-718, 2008.

[10] Yan, X. R., S. S. Zhong, and X. X. Yang, “Compact printed monopole antenna with super-wideband," Proceedings of the International Symposium on Microwave, Antenna, Propagation and EMC Technologies for Wireless Communications, 605-607, China, 2007.

[11] Werner, D. H. and S. Ganguly, “ An overview of fractal antenna engineering research," IEEE Antennas and Propagation Magazine,” Vol. 45, No. 1, 38-57, 2003.

[12] Gouyet, J. F., “Physics and Fractal Structures,” Springer, Paris, 1996.

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