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Design of Wideband Fractal Antenna

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Abstract: Self similar arrays have frequency independent multi band characteristics. This paper presents the design of fractal antenna based on the Koch curve geometry. The antenna has been optimized to operate in multiple bands between 3-8 GHz and efficiency of 85 percentages with a peak gain of 4db. Design and analysis of fractal antenna is done by using CST software. The results show that the designed Koch Curve antenna is suitable for wireless applications.

Keywords: Wideband, Fractal, Koch curve, CST

I. INTRODUCTION

In modern wireless communication systems and increasing of other wireless applications, wider bandwidth, multiband and low profile antennas are in great demand for both commercial and military applications. This has initiated antenna research in various directions; one of them is using fractal shaped antenna elements. Traditionally, each antenna operates at a single or dual frequency bands, where different antenna is needed for different applications. This will cause a limited space and place problem. In order to overcome this problem, multiband antenna can be used where a single antenna can operate at many frequency bands. One technique to construct a multiband antenna is by applying fractal shape into antenna geometry.

In recent years several fractal geometries have been introduced for antenna applications with varying degrees of success in improving antenna characteristics. Some of these geometries have been particularly useful in reducing the size of the antenna, while other designs aim at incorporating multi-band characteristics. Yet no significant progress has been made in corroborating fractal properties of these geometries with characteristics of antennas. The research work presented here is primarily intended to analyze geometrical features of fractals that influence the performance of antennas using them. Several antenna configurations based on fractal geometries have been reported in recent years. The use of fractal geometries has significantly impacted many areas of science and engineering; one of which is antennas. Antennas using some of these geometries for various telecommunications applications are already available commercially.

There are many benefits when we apply these fractals to develop various antenna elements. The combination of infinite complexity and detail and self similarity makes it possible to design antennas with very wideband performance. By applying fractals to antenna elements:

- We can create smaller antenna size
- Achieve resonance frequencies that are multiband
- May be optimized for gain
- Achieve wideband frequency band

II. KOCH CURVE GEOMETRY

The curve of Von Koch is generated by a simple geometric procedure which can be iterated an infinite number of times by dividing a straight line segment into three equal parts and substituting the intermediate part with two segments of the same length. The same pattern appears everywhere along the curve in different scale, from visible to infinitesimal. Ideally the iteration process should go on indefinitely; however, in practice, the curve displayed on the screen no longer changes when the elementary side becomes less than the pitch. And the iteration can be stopped as well. The Von Koch Curve is a very elementary example of fractal, as it follows a simple rule of construction.

1. Start with a straight line.

2. The straight line is divided into 3 equal parts, and the middle part is replaced by two linear segments at angles 60º and 120º.

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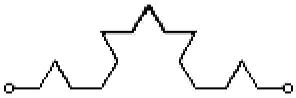
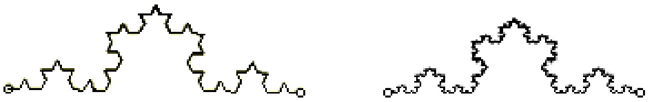
3. Repeat the steps 1 and 2 to the four line segments generated in two.



4. Further iterations will generate the following curves.



In order to maintain the displacement in between the two points constant, the length of the size multiplied by 4/3 in each iteration. From this simple rule of iteration, we can come up with a formula for the total length of the Koch Edge in the nth iteration. L = (4/3)^n.

After each iteration, every single edge turns into four equal sized segments with length 1/3 of the original length. Thus, after n iterations, the total number of the Koch Edge will be 4^n.

If we apply the above process on the two sides of an equilateral triangle (exclude the inner side), we will have the following pattern:

III. CST MICROWAVE STUDIO

CST (Computer Simulation Technology) MICROWAVE STUDIO® (CST MWS) is a specialist tool for the 3D EM simulation of high frequency components. CST MWS enables the fast and accurate analysis of high frequency (HF) devices such as antennas, filters, couplers, planar and multi-layer structures and SI and EMC effects. It is available as a part of CST Studio suit. It comprises CST's tools for the design and optimization of devices operating in a wide range of frequencies - static to optical. CST STUDIO SUITE benefits from an integrated design environment which gives access to the entire range of solver technology. System assembly and modelling facilitates multi-physics and co-simulation as well as the management of entire electromagnetic systems. CST develops and markets high performance software for the simulation of electromagnetic fields in all frequency bands. It is powerful modelling software.

IV. ANTENNA DESIGN

The proposed antennas are microstrip line fed and their structure is based on fractal geometry where the resonance frequency of antenna is lowered by applying iteration techniques. Analysis of fractal antenna was done by using the Software named CST Microwave Studio Suite. An antenna based on Koch Fractal geometry and Microstrip line feeding technique for wideband wireless application is studied in this section .The Koch curve structure is applied to the upper, bottom, left and right side of a rectangular patch.

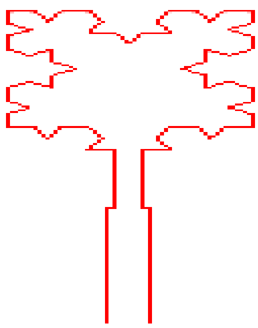


Figure1. Geometry of the proposed Koch fractal antenna

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The Geometry of the proposed of Koch curve fractal antenna is shown in Figure 1. Here, the Koch Fractal is considered in simple rectangular patch edges to expand the antenna bandwidth. The proposed antenna is built on one side of FR-4 dielectric substrate (thickness t_s=1.6mm and relative permittivity ε_r=4.4) of 15×30×1.5mm^3. It is fed by 50Ω Microstrip line feeding technique of 2.0×10×0.05mm^3 for the transmission line portion and 1.0×5×0.05mm^3 for the quarter wave transformer portion. A first iteration of Koch Fractal Geometry of iteration factor of 3 is applied to the rectangular patch of dimensions 10×10×0.05mm^3. The proposed antenna uses a partial ground plane of dimensions 14×13.0×0.05mm^3.

V. SIMULATION RESULTS

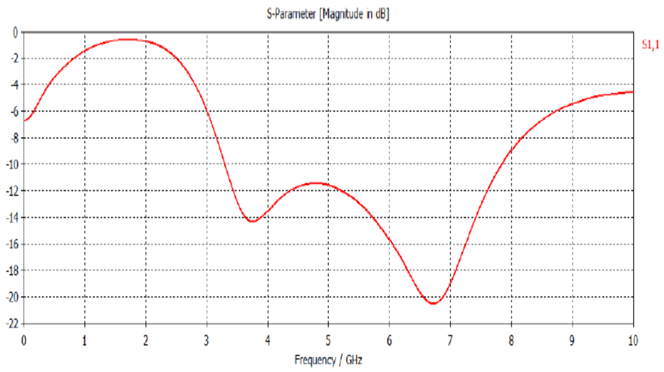

Figure2. Return loss for 13mm width of the ground plane

Figure 2 shows the simulated reflection coefficients of the proposed antenna. The width has a prominent effect on the wideband operation of the proposed Fractal antenna. Although the length of the ground plane has negligible effect, it is fixed in this case.

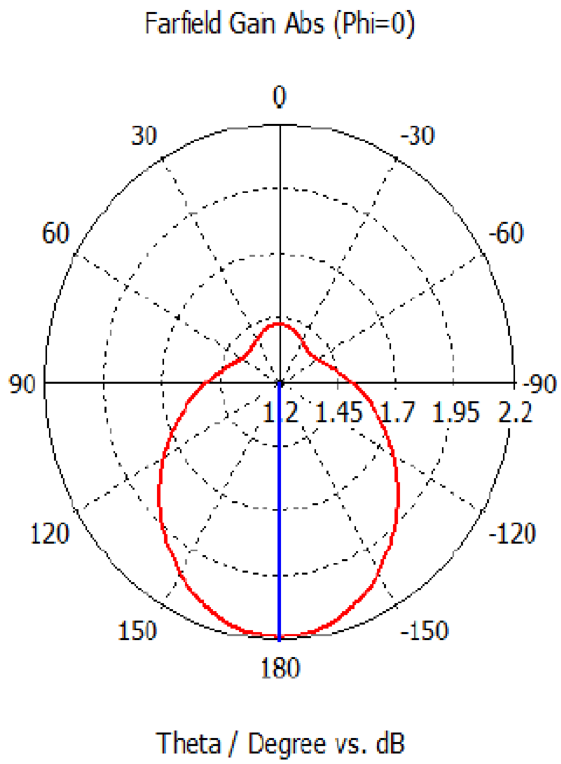

Figure3. Radiation pattern at 3 GHz

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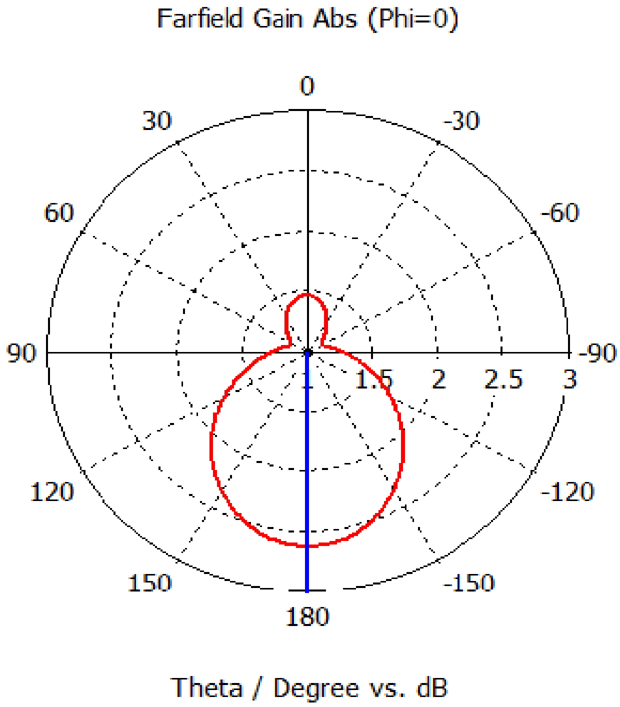

Figure4. Radiation pattern at 5 GHz

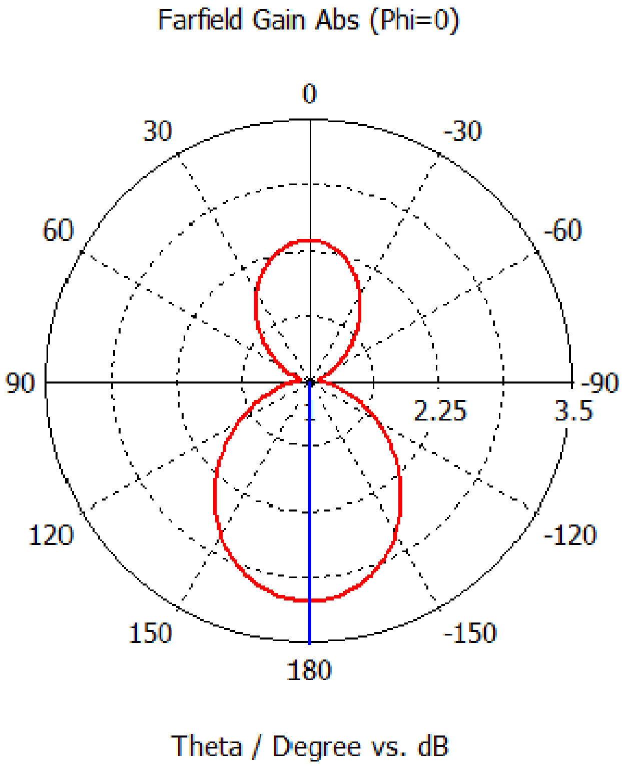

Figure5. Radiation pattern at 8 GHz

Figure 3, Figure 4 and Figure 5 illustrate the simulated 2D radiation patterns of the proposed antenna at 3 GHz, 5 GHz and 8 GHz. It shows that the patterns are omni directional in nature for wideband frequency.

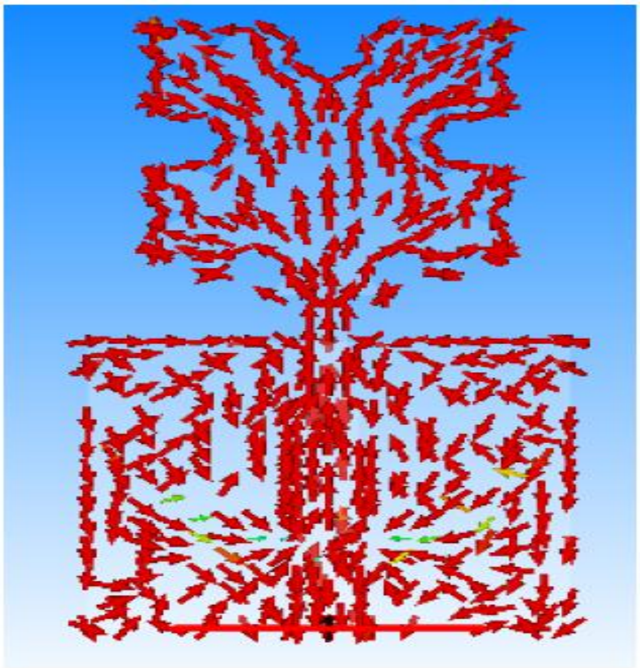

Figure6. Surface current distribution at 5 GHz

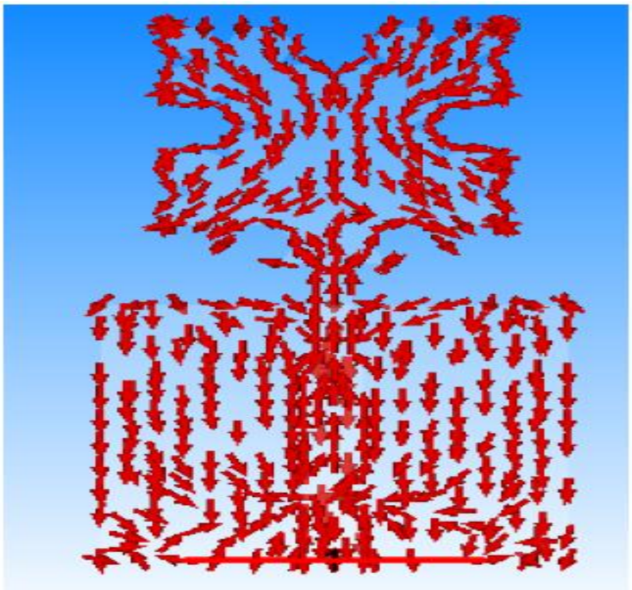

Figure7. Surface current distribution at 8 GHz

Figure 6 and Figure 7 illustrate the simulated 2D surface current distribution of the proposed antenna at 5 GHz and 8 GHz respectively.

VI. TABLE OF RESULTS

Frequency (GHz)	Return loss (db)	Gain (db)	Efficiency (%)
3	-13.2	2.4	88.5
5	-18.5	3.1	87.6
8	-10.3	4.0	85.1

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VII. CONCLUSION

In this paper a compact Koch curve fractal antenna has been designed which can be used for wireless applications. CST microwave studio was employed for simulating the results. A large bandwidth was obtained by incorporating self similar fractal slots in the patch and introducing slots in the ground plane. It is expected that this antenna will find applications in Wi-Fi, WLAN and WiMAX wireless communications.

REFERENCES

[1]. A.Azari, J.Rowhani, "Ultra wideband fractal microstrip antenna design", progress In Electromagnetic Research, vol 2, pp.7-12, 2008.
[2]. Abolfazl Azari, "A New Super Wideband Fractal Microstrip Antenna", IEEE transactions on antennas and propagation, vol.59, no.5, pp.17241727, 2011.
[3]. Muhammad Waqas, Zubair Ahmed, Mojeeb Bin Ihsan,"Multiband Sierpinski Fractal Antenna", IEEE, 2009.
[4]. Saira Joseph, Binu Paul, Shanta Mridula, Pezholil Mohanan, "A Novel Planar Fractal Antenna with CPW-Feed for Multiband Applications", a novel planar fractal antenna with cpw feed for radio engineering, vol.22, no.4, pp.1262-1266,2013.
[5]. Douglas H. Werner, Suman Ganguly, "An Overview of Fractal Antenna Engineering Research", IEEE Antennas and Propagation Magazine, Vol.45, No.1, 2003.
[6]. Chakkrit Kamtongdee1 and Nantakan Wongkasem," a Novel Design of Compact 2.4 GHz Microstrip Antennas", IEEE, pp.766-769, 2009.
[7]. Deepti Das Krishna, Student Member, IEEE, M. Gopikrishna, Student Member, IEEE, C. K. Anandan, P. Mohanan, Senior Member, IEEE, and K. Vasudevan, Senior Member, IEEE, " CPW-Fed Koch Fractal Slot Antenna for WLAN/WiMAX Applications",IEEE antennas and wireless propagation letters, vol. 7,pp.389392,2008.
[8]. A.A.Lotfi-Neyestanak, M.R.Azadi and A.Emami-Forooshani," Compact Size Ultra Wideband Hexagonal Fractal Antenna", IEEE, pp.387-390, 2010.
[9]. Muhammad Naeem Iqbal, Hamood-UrRahman, and Syeda Fizzah Jilani," an Ultra wideband Monopole Fractal Antenna with Coplanar Waveguide Feed", International Journal of Antennas and Propagation Volume 2014, Article ID 510913, 7 pages, 2014.
[10]. N. Cohen, "Fractal antenna applications in wireless telecommunications," in Professional Program Proc. of Electronics Industries Forum of New England, 1997, IEEE, pp. 43-49, 1997.
[11]. S. Suganthi, Member IACSIT D. Kumar, and S. Raghavan," Design and Simulation of Miniaturized Multiband Fractal Antennas for Microwave Applications", International Journal of Information and Electronics Engineering, Vol. 2, No. 5, pp.825-830,2012.
[12]. C. Puente-Baliarda, J. Romeu, R. Pous, J. Ramis, and A. Hijazo, "Small but long Koch fractal monopole," Electron. Lett., vol. 34, pp. 9-10, 1998.
[13]. B.B. Madelbrot, The Fractal Geometry of Nature, New York: W.H. Freeman, 1983.