Study of Koch Monopole Fractal Antenna

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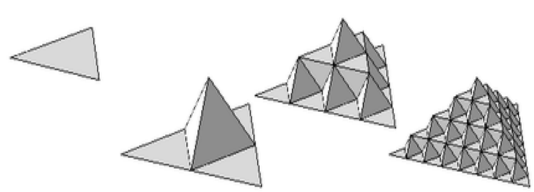
Abstract

In this work, the design of Koch monopole fractal antenna to be used in wireless communications at the ISM frequency band is presented. Antenna's shape and dimensions are optimized to achieve area minimization, by applying the properties of fractal shapes at the radiating slots. The property of self-similarity that fractal shapes possess has been successfully applied in other types of antennas with great success. The effects of fractal miniaturization in this type of antennas, mainly regarding the radiation pattern, the antenna efficiency, and applicability of fractal shapes in the design of antenna as for wireless communication systems are presented herein.

1. Introduction

Nowadays, wireless communication systems are becoming increasingly popular. There have been ever growing demands for antenna designs that possess the following highly desirable attributes: compact size, low profile, multi-band [3–4], wide bandwidth [5], etc. There are varieties of approaches that have been developed over the years, which can be utilized to achieve one or more of these design objectives. Recently, the possibility of developing antenna design objective has been improved due to the use of fractal concept. The term of the fractal geometries was originally coined by Mandelbrot [3] to describe a family of complex shapes that have self-similarity or self-affinity in their geometrical structures. the term fractal, which means broken or irregular fragments, was originally coined by Mandelbrot[3]to describe a family of complex shapes that posses inherent self similarity in their geometrical structure. One of the most promising area of the fractal application is in its application[5] to antenna and design.



The proposed antenna is designed with the consideration to effectively support personal communication system (PCS 1.85–1.99 GHz), universal mobile telecommunication system (UMTS 1.92–2.17 GHz), wireless local area network (WLAN), which usually operate in the 2.4 GHz (2.4–2.484 GHz) and5.2/5.8 GHz (5.15–5.35 GHz/5.725–5.825 GHz) bands, mobile worldwide interoperability for microwave access (Mobile WiMAX), and

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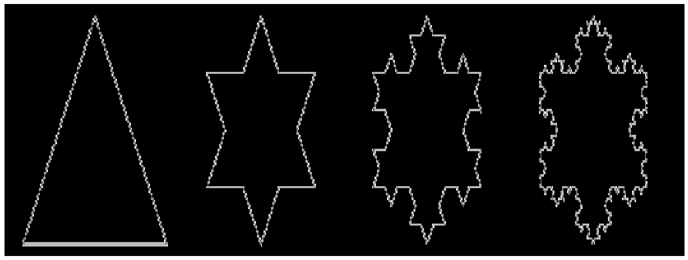
WiMAX, which operate in the 2.3/2.5 GHz (2.305–2.360 GHz/2.5–2.69 GHz) and5.5 GHz (5.25–5.85 GHz) bands[6].



Let [7]A_k be the area at iteration, then the area of the next iteration can be computed as

$$A_{k+1}=A_k+\frac{\sqrt{3}}{12}\left(\frac{4}{9}\right)^{k-1}a^2. \tag{1}$$

Where is the side of the initial triangle that has an area$A_0=\sqrt{\frac{3}{4}}a^2$.The geometric series given by (1) converges to

$$A=\frac{2}{5}\sqrt{3a^2} \tag{2}$$

All the iterations are circumscribed inside a circumference of Radius r $=\frac{\sqrt{3a}}{3}$[1].On the other hand, the perimeter increases at each new iteration. The overall perimeter for iteration k is given by

$$l_k=3a\left(\frac{4}{3}\right)^k \tag{3}$$

2. Antenna Design

Because of their geometric complexity, it is very difficult to predict mathematically the fractal antenna radiation pattern [8-10]properties. The wide availability of the powerful electromagnetic simulator makes possible of such problems, which would be otherwise impossible to solve. We use the fractal design similar to figure 1, iterations of Koch monopole antenna. The scale factor for all iteration is 0.75. 2-iternations, are applied as the radiation part here for the fractal, an infinite perimeter bounding a finite area is obtained. Despite of the increasing irregularity of the boundary, the manufacturing process does not become more complex at each new iteration. The geometry of the proposed antenna is shown in figure 2. The Fractal tree structure design has following specification area of main patch A=35.07cm^2(a=9cm), we have used Roger/RT5880(tm), Substrate height h=2cm, permittivity of the substrate =2.2 and resonant Frequency is2.4GHz. The proposed geometry is excited by probe feeding technique. By using this method we have design three iterations as shown in Fig.1 and the proposed second iterative design of Koch monopole fractal antenna showing improved results as in Fig.2

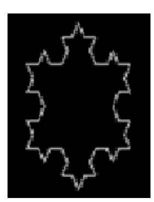


Fig.2 Second iteration of Koch monopole antenna

3. Result And Discussion

Results of first 3 iterations of Koch monopole antenna are shown below:

3.1 Return loss

Return losses of first three iteration of Koch monopole antenna are

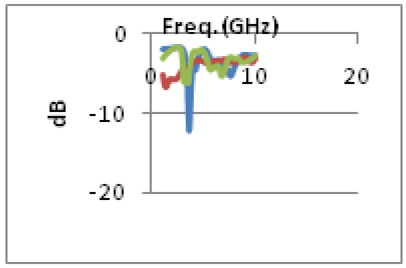


Fig.3 Return losses of first three iterations.

For second iteration at 3.5 GHz frequency return loss is -12.2508 dB and for first iteration at 1.27GHz frequency return loss is -6.6950dB.

3.2 Gain

Gains of three iterations are as follows:

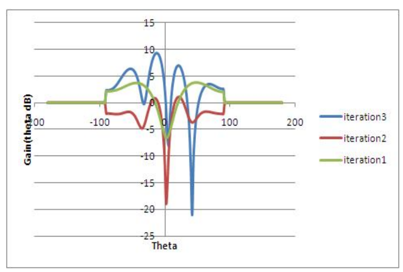


Fig.4Gain of first three iterations.

For second iteration at 42^0 gains is -21.0031dB and for first iteration at 4^0 gains is -32.0117 dB.

3.3 Terminal VSWR

Terminal VSWR of first three iterations of Koch monopole antenna are as follows:

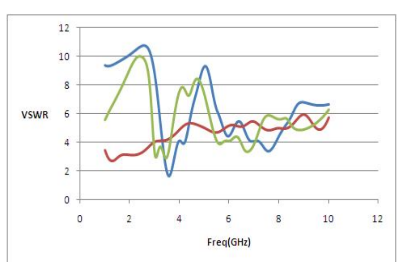


Fig.5 Terminal VSWR of three iterations

For second iteration VSWR is 1.6 at 3.5GHz and 2.7 at 1.27 GHz for first iteration. The design of all five iteration of the novel printed on dielectric substrate. The antenna has been fed using 50 Ω coaxial probes to main stem. In this study, the permittivity of the substrate is 2.2. Return loss, VSWR, VSWR bandwidth, and direction pattern is plotted. This gives the change in the pattern direction respectively with number of iteration VSWR shows the good result for third iteration.

4. Conclusion

A Koch monopole antenna is presented in this paper .It is observed that the resultant antenna is compact in size and simple to design. Our aim was, to see the results of antenna using coaxial probe fed method. The proposed antenna is simulated for 2.4 GHz frequency in this paper, which finds its application in LAN.

5. References

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