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Design and simulation of compact planar Inverted Folded Fractal antennas

B.T.P.Madhav, M.Ravi Kumar, U.Chandra Sekhar Rao, D.Lokesh Chowdary, K.Narendra and P.Sai Krishna

Department of ECE, K L University, Guntur DT, AP, India.

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ABSTRACT

Design and simulation of planar inverted folded fractal antennas are designed to operate at wireless communication applications. The proposed models are having size reduction of 15-20% compared to the conventional antennas and operating with stable gain and good bandwidth. First model is resonating at 2.6 GHz and second model is at 2.8 GHz. This paper addresses the development of compact and efficient planar inverted fractal antenna with some methods for improving the bandwidth and reduction in volume. Ansoft HFSS electromagnetic simulation software has been used to simulate the performance of these fractal structured PIFA antennas.

Introduction

The rapid increase in the need and demand for wireless technology in the recent years has driven the antenna designers to design new antennas that simultaneously appear miniaturized and at the same time useful for many wireless standards [1]. There are many methods for the design of antennas for various applications and improving their performances [2]. In this paper the fractal shaped antennas are proposed for wireless communication applications [3]. Fractals mean irregular or broken fragments. Fractal geometries describe a complex set of geometries ranging from self-similar to other irregular structure [4]. Fractal antennas are used in wide range of frequencies for various wireless applications. Miniature antennas are of prime importance in wireless communication due to available space limitations.

PIFA can be considered as a kind of linear Inverted F antenna (IFA) with the wire radiator element replaced by a plate to expand the bandwidth. The PIFA has many advantages, that is, easy fabrication, low manufacturing cost, and simple structure [5-6]. PIFA can be hiding in the housing of the mobile phone when comparable to whip/rod/ helix antennas. Besides, PIFA has reduced backward radiation towards the user's head, minimizing the electromagnetic wave power absorption (SAR) and enhance antenna performance. It exhibits moderate to high gain in both vertical and horizontal states of polarization [7-8]. This feature is very useful in certain wireless communications where the antenna orientation is not fixed and the reflections are present from the different corners of the environment. In those cases, the important parameter to be considered is the total field that is the vector sum of horizontal and vertical states of polarization. But the major disadvantage that keeps the basic PIFA from diverse application is its narrow bandwidth; therefore it is necessary to broaden bandwidth for use in mobile phones and other applications [9-10].

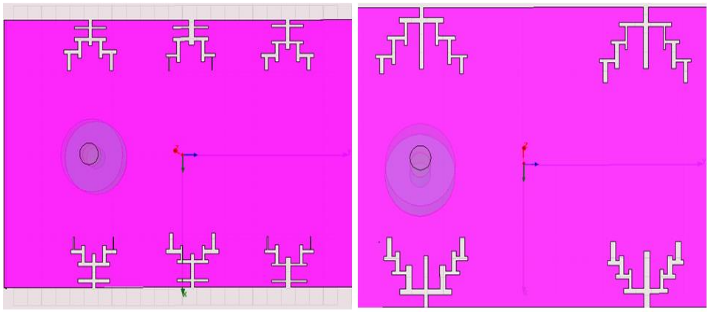

Figure 1 Fractal Shaped Shorting Plate PIF Antennas

Figure 1 shows the Fractal PIFA antennas with coaxial feeding. However, PIFA antennas have some disadvantages such as low efficiency, narrow bandwidth and no multiband capability. To overcome these drawbacks, especially narrow bandwidth, and to meet the miniaturization requirements of mobile units, the Fractal PIFA antenna has been proposed to achieve the design of internal compact and broadband microstrip patch antennas. Fractal antennas consist of elements patterned after self-similar designs to maximize the length, or increase the perimeter [11]. These have useful applications in cellular telephone and microwave communications. Furthermore, it is found that a small adjustment of the shape can make it work at the required resonant frequencies [12].

Antenna Design: The configuration of the proposed antennas is shown in the figure 1. Figure 1(a) consisting of a rectangular radiating element with fractal structures of six slotted shapes. RT-duroid substrate material of dielectric constant 2.2 and height of 1.6 mm is chosen for the current designs. The shorting plate consists of a vertical conducting strip and it is used not only to connect between the patch and ground, but also to support the whole antenna. The 50Ω coaxial probe has a radius of 0.5mm and is fed on the centre line of the rectangular patch. The distance between the feeding position and the shorting plate varies depending on the fractal's iterations. The coaxial feed excites the PIFA's TM10 mode. The operating frequency of a microstrip patch antenna is inversely proportional

Tele:
E-mail addresses: btpmadhav@kluniversity.in

to its physical dimensions. For a standard, coax-fed, quarter-wave microstrip patch antenna, the operating frequency can be approximately determined from the length of antenna patch as

F = c/4(λd). Where λd is the wavelength inside the substrate (L1 +L2). The length L1 and the width L2 is subsequently optimized to obtain an improved frequency match by doing an optimization procedure through experimental trials. Figure 2(b) shows the fractal structure with four slotted shapes.

Results and Discussion:

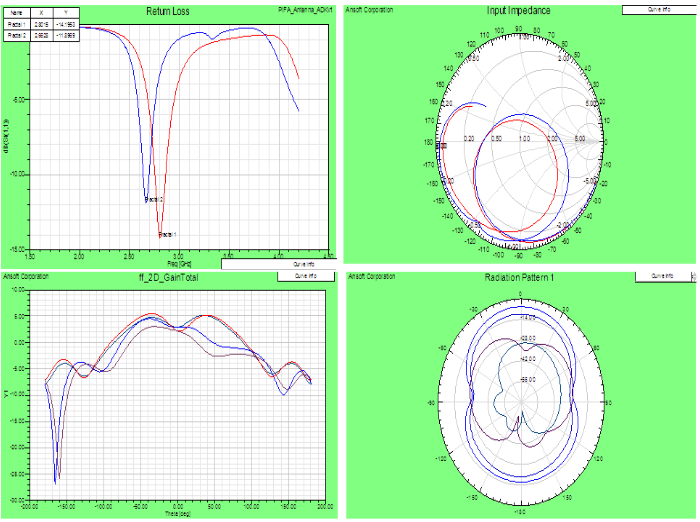

Figure 2 (a) Return loss, (b) Input Impedance Smith Chart, (c) Gain, (d) Radiation Pattern

Figure 2 shows the return loss curve for the proposed antennas. First model is operating at 2.8 GHz with return loss of -14 dB and the second model is operating at 2.6 GHz with return loss of -11.8 dB. Figure 2b shows the input impedance smith chart. Bandwidth enhancement of 1% from first model and 0.75% from the second model is attained with the proposed models. Figure 2c shows the gain curve for both the antennas on a single plane with more than 3 dB at operating frequencies. Figure 2d shows the quasi Omni directional radiation pattern for both the antennas at phi equal to 0^0 and 90^0. Figure 3 shows the radiation pattern of the antennas in three dimensional view. Figure 4 shows the current distribution on the surface of the patch of PIFA antennas at resonating frequencies.

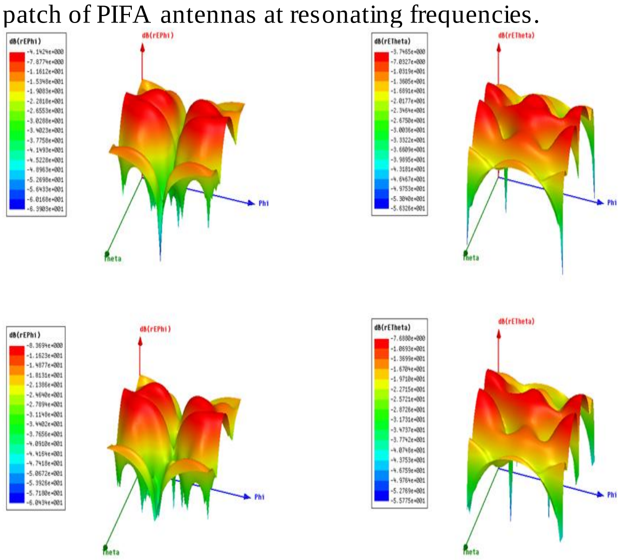

Figure 3 Three dimensional radiation pattern for proposed models

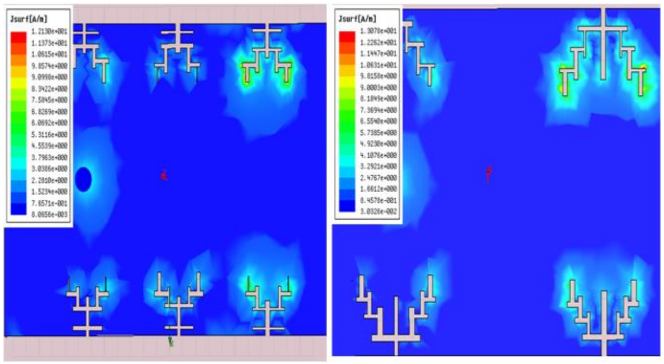

Figure 4 Current Distributions on Fractal PIFA Antennas

Antenna Parameters:

Quantity	Value	Units
Max U	0.00066	W/sr
Peak Directivity	3.3232	
Peak Gain	3.2945	
Peak Realized Gain	1.8563	
Radiated Power	0.0024958	W
Accepted Power	0.0025176	W
Incident Power	0.004468	W
Radiation Efficiency	0.99134	
Front to Back Ratio	9.1554	

Antenna Parameters:

Quantity	Value	Units
Max U	0.00026453	W/sr
Peak Directivity	3.584	
Peak Gain	3.4797	
Peak Realized Gain	0.69502	
Radiated Power	0.00092751	W
Accepted Power	0.00095534	W
Incident Power	0.004783	W
Radiation Efficiency	0.97087	
Front to Back Ratio	9.5784	

Table 1 Antenna Parameters

Conclusion: Fractal shaped PIFA antennas are designed and their performance characteristics are simulated and presented in this paper. Six pedal elements fractal shaped PIFA is designed to operate at 2.8 GHz and four pedal elements fractal shaped PIFA is designed to operate at 2.6 GHz with stable gain. Six pedal elements fractal PIFA is having radiation efficiency 0.02% more than the four pedal elements fractal PIFA. The first model is having bandwidth enhancement of 1% and second model of 0.75% compared to normal PIFA antenna operated at those resonant frequencies. First model is having return loss of -14dB and VSWR of 1.4, whereas the second model having return loss of -11.8dB and VSWR of 1.6. Both the models are showing quasi Omni directional radiation pattern and results are giving the encouragement that these two models are applicable for the wireless communication applications

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References:

[1] T. W. Hee, P. S. Hall, C. T. Song, “Fractal PIFA, Dipole and Monopole Antennas,” IEEE Topical Conference on Wireless Communication Technology, pp.275-276, 2003.

[2] D. Delaune, N. Guan, K. Ito, “Simple Multiband Antenna for Mobile Phone Application Based on a Dual-arm Monopole Structure,” PIERS Online, Vol. 4, No. 1, 2008.

[3] C. Puente, J. Romeu, A. Cardama, “Fractal-Shaped Antennas, in Frontiers in Electromagnetic,” edited by D.H. Werner, R. Mittra, IEEE PRESS, 2000.

[4] J.P. Gianvittorio, S.Y. Rahmat, “Fractal Antennas: A Novel Antenna Miniaturization Technique, and Applications,” IEEE, Antennas and Propagation Magazine, Vol.44, No.1, pp.20-36, February 2002.

[5] R. B. Waterhouse, Microstrip Patch Antenna, Kluwer Academic Publishers, Boston, 2003.
[6] R. Garg, P. Bhartia, I. Bahl, A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, Boston, 2001.
[7] B.T.P.Madhav, Prof. VGKM Pisipati, N.V.K Ramesh, Prof. Habibulla Khan, Prof. P.V.Datta Prasad, "PLANAR INVERTED-F ANTENNA ON LIQUID CRYSTAL POLYMER SUBSTRATE FOR PCS, UMTS, WIBRO APPLICATIONS", APPN Journal of Engineering and Applied Sciences, VOL. 6, NO. 4, APRIL 2011 ISSN 1819-6608.
[8] B.T.P.Madhav, N.V.K.Ramesh, M.J.Kiriti, B.S.N.Benarji, B.Divya, "Feeding position Effects on the performance of Planar Inverted Folded Antenna", ARPN Journal of Systems and Software, ISSN 2222-9833, Volume 1 No. 7, October 2011.
[9] B.T.P. Madhav, VGKM Pisipati, Habibulla Khan, P.V. Datta Prasad, "Shorting Plate Planar Inverted Folded Antenna on LC Substrate for Bluetooth Application", Journal of Engineering Science and Technology Review, ISSN: 1791-2377, Vol 5, Issue 2, (2012) , pp 42-45.
[10] M. A. Ebrahimi-Ganjeh, "Interaction of Dual Band Helical and PIFA Handset Antennas with Human Head And Hand", Progress In Electromagnetics Research, PIER 77, 225–242, 2007.
[11] Chen, Z. N., Antennas for Portable Devices, Wiley, 2007.
[12] C. A. Balanis, "Antenna Theory, Analysis and design", Third edition, New Jersey, John Wiley & Sons, 2005.