DESIGN OF FRACTAL PATCH ANTENNA

Tarang H Thakar

ME (D.C),Electronics And Communication Department,Parul Institute Of Engineering & Technology,Vadodara,Gujrat,India. ***Tarang.Thaker3@Gmail.Com***

Abstract

With The Advance Of Wireless Communication Systems And Increasing Importance Of Other Wireless Applications, Wideband And Low Profile Antennas Are In Great Demand Or Both Commercial And Military Applications. Multi-Band And Wideband Antennas Are Also Desirable In Personal Communication Systems, Small Satellite Communication Terminals, And Other Wireless Applications. Due To The Recent Interest In Broadband Antennas A Micro Strip Patch Antenna Was Developed To Meet The Need For A Cheap, Low Profile, Broadband Antenna. This Antenna Could Be Used In A Wide Range Of Applications Such As In The Communications Industry For Cell Phones Or Satellite Communication. This Optimization Method Greatly Reduced The Time Needed To Find Viable Antenna Parameters. A Dual Input Patch Antenna With Over 30% Bandwidth In The X-Band Was Simulated Using Ansoft's High Frequency Structural Simulator (HFSS) In Conjunction With Particle Swarm Optimization.[1] Frilctals have no characteristic size, and are generally composed of many copies of themselves at different scales. These uniqile properties of fractals have been exploited in order to develop a new class of antenna-element designs that are multi-band and/or compact in size.[4]

Index Tearms--- *Antennas, Fractal, Fractal Microstrip Antenna*

1 INTRODUCTION

various fractal shapes that possess self-similarity have been applied to multiband or miniaturized antenna design [1]. A promising fractal geometry that ensures a successful design of a multiband antenna is known as the Sierpinski gasket. Multiresonant behaviors of the five-iteration Sierpinski gasket mounted over a large conducting ground plane are described in [2]. A perturbed Sierpinski multiband fractal antenna fed by a 50 Ω microstrip line is considered in [3]. The microstrip feed technique has been shown to enhance the poor matching properties of conventional Sierpinski monopole antennas. Other examples of a multiband fractal antenna based on a hexagonal fractal or a multiple circular ring fractal can be found in [4], [5]. Broadband fractal antennas have also been investigated using a stacked Sierpinski gasket or carpet [6], [7]. These fractal volume concepts increase not only the input bandwidth but also the thickness of the antenna.

This letter proposes a broadband planar fractal antenna that consists of a flared Sierpinski gasket and a slotted ground plane for multiband communication services. As a low-profile antenna, the proposed antenna covers the GSM (880–960 MHz), DCS (1710–1880 MHz), PCS (1850–1990 MHz), IMT-2000 (1900–2200 MHz), ISM (2400–2484 MHz), and satellite DMB (2605–2655 MHz) bands with 10-dB return loss criterion. in the recent years with the widespread deployment of short distance wireless communications, like the wireless local area networks (WLAN). WLAN's are designed to operate in the 2.4 GHz (2.4–2.48 GHz) and 5 GHz frequency bands (5.15–5.35 GHz and 5.725–5.825 GHz in the United States and 5.15–5.35 GHz and 5.47–5.725 GHz in Europe). Also there is the easily deployable, low cost, broadband wireless access commonly known as WiMAX (Worldwide Interoperability for Microwave Access) which is allocated the 2.5–2.69/3.4–3.69/5.25–5.85 GHz bands. Since these standards may be used simultaneously in many systems, there is a need for a single antenna which covers all these bands.

1.1 SIERPIESKI CARPET

SIERPINSKI CARPET Fractal Antenna is realised by successive iterations applied on a simple Square patch as shown in fig 4.5(a), which can be termed as the zeroth orderiteration. A Square of dimension equal to one third of the main patch is subtracted from the centre of the patch to retrieve first order iteration, as shown in figure 1 (b). The next step is to etch Squares which are nine times & twenty seven times smaller than the main patch a demonstrated in fig 1 (c) & (d) respectively. The second & third order iterations are carried out eight times & sixty four times respectively on the main patch. This Fractal can be termed as third order Fractal as it is designed by carried out three iterations. The pattern can be defined in such a way that each consequent etched square is one third in dimension as compared to the previous one sharing the same centre point.[3]

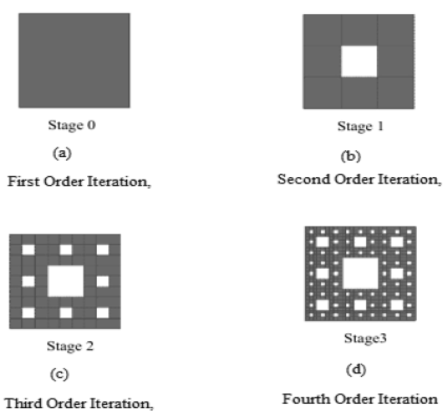

Fig -1 Four stages of construction of SIERPINSKI CARPET.[3]

1.2 KOCH CURVE

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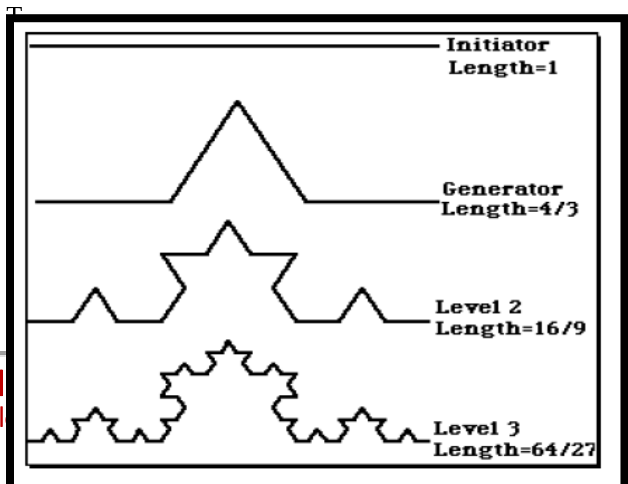


ric construction of the standard Koch curve is fairly simple. It starts with a straight line as an initiator. This is partitioned into three equal parts and the segment at the middle is replaced with two others of the same length. This is the first iterated version of the geometry is called Generator. The Process is reused in the generation of higher iterations.[20]

FIG-2 STEPS OF CONSTRUCTION OF KOCH GEOMETRY.[6]

1.3 SIERPINSKI GASKET GEOMETRY

SIERPINSKI Gasket Geometry is the mostly widely studied FRACTAL geometry for Antenna applications. SIERPINSKI Gaskets have been investigated extensively for monopole and dipole antenna configurations. The self-similar current distribution on these antennas is expected to cause its multi-band characteristics. It has been Found that by Perturbing the geometry the multiband nature of these antennas can be controlled. Variations of the flare angle of these geometries have also been explored to change the band characteristics of antenna. Antennas using this geometry have their performance closely linked to conventions bow-tie antennas. However some minor differences can be noticed in their performance characteristics. It has been found that the multi-band nature of the antenna can be transformed into wide-band characteristics by using a very high dielectric constant substrate and suitable absorbing materials.[13]

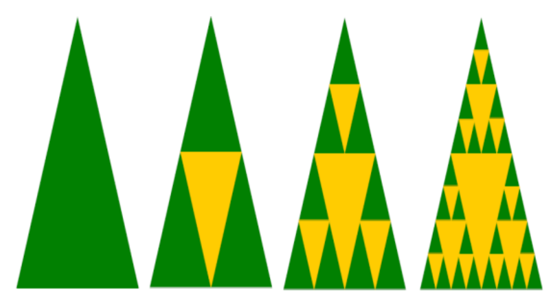


FIG-3 FOUR STAGES OF CONSTRUCTION OF SIERPINSKI CARPET[13]

2 RESULT

2.1 1ST ITERATION RESULT OF SIERPINSKI CARPET FRACTAL PATCH ANTENNA

Design of the Sierpinski Carpet FRACTAL Patch antenna for first iteration is found by taking 1/3 Dimension cut of the patch from the central. This type of design is as shown in the figure.[11] By the use of FR4 epoxy material get the resonance at two different frequency 2.5 GHz and 3.56 GHz. Return loss of about -31.05 and -22.65 are get with this design.

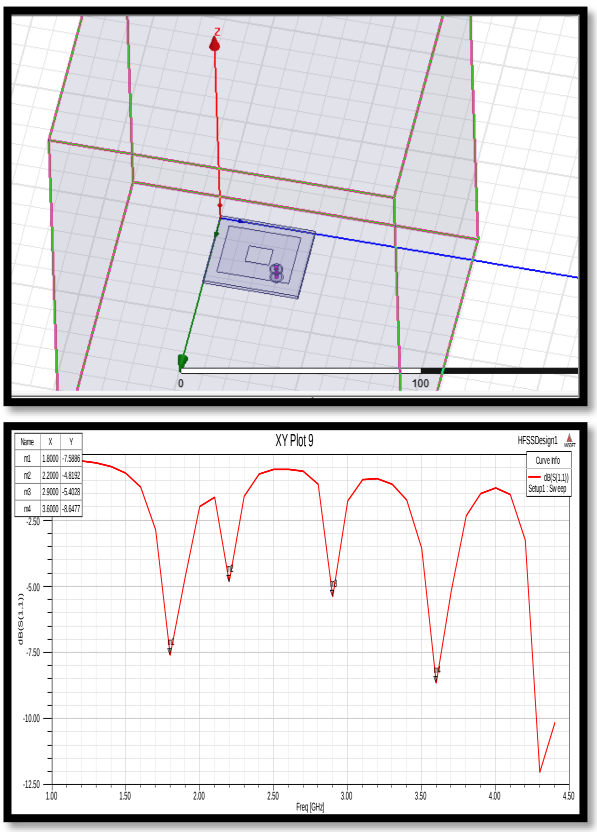


FIG- 4 (A) 1st Iteration Of Sierpinski Carpet Fractal Patch Antenna With multi band 2.4 GHz and 3 Ghz Frequency (B) Measured Result

2.2 2nd ITERATION RESULT OF SIERPINSKI CARPET FRACTAL PATCH ANTENNA

As per the design rule in the FRACTAL Patch antenna another 1/3 dimention cut means total 1/9 dimention cut from the original design procedure will be carry out in this design step,so total 8 new slots will be cut from the main design in this step[11].Main intense of doing this procedure is nothing but getting desirable Bandwidth with this procedure. With this design we are able to get Resonance at two frequencies 2.5 GHz and 3.62 GHz. Return loss of -25.2049 and -29.3071 are possible with this design.

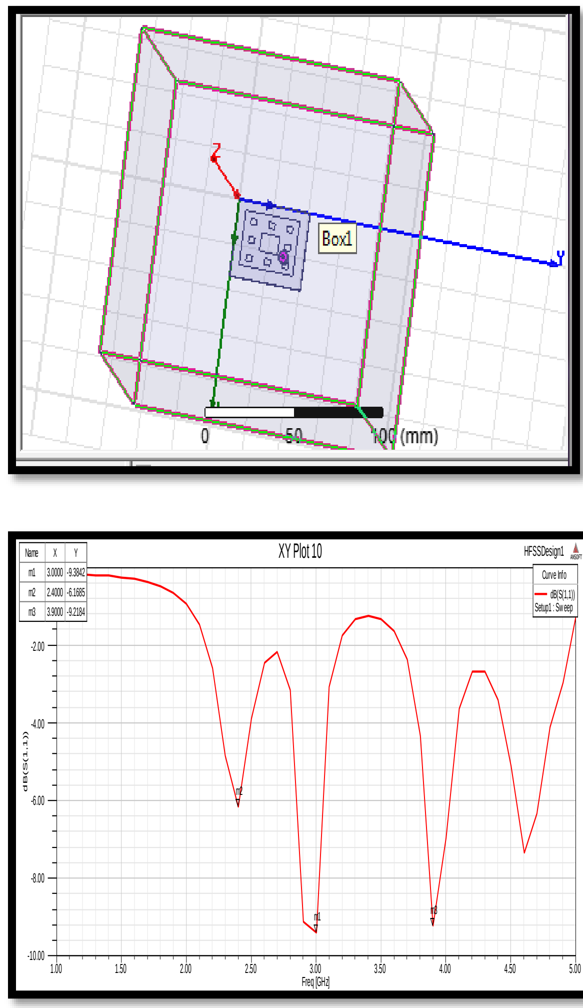


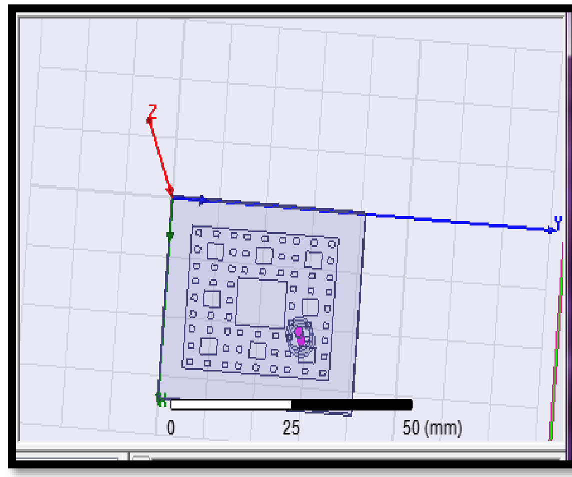
Fig-5 (A) 2nd Iteration Of Sierpinski Carpet Fractal Patch Antenna With 3 Ghz Frequency (B) Measured Result

2.3 3rd ITERATION RESULT OF SIERPINSKI CARPET FRACTAL PATCH ANTENNA

Figure shows top view of the third iteration of Sierpisnki carpet FRACTAL Patch antenna having 1/27 dimension of the smallest dimension in the design. So with the use of this design we are able to get Multi band characteristic of the design.[11] FR4 Epoxy material give Dual band response. As shown in the figure we get dual band response at 2.49 GHz and 3.61 GHz Frequencies. We get Return loss of about -34.1902 at 2.49 GHz and -22.0396 at 3.61 GHz frequencies.

CONCLUSION

In This Analysis We Understand Basic Knowledge About The Sierpinski Carpet And Sierpinski Gasket Fractal Patch Antenna. Microstrip Fractal Shaped Antennas Developed To Be Used In Small Mobile Terminals With Multistandard Operation Have Been Presented. It Was Shown That The Proposed Antenna Has Two Operational Bands (808–1008 And 1581–2760 Mhz), And That The Bands Cover The Gsm/Dcs/Pcs/ Imt-2000/Ism/Satellite Dmb Services. The Essence Of The Maintenance Of The Antenna Radiation Patterns Is The Self-



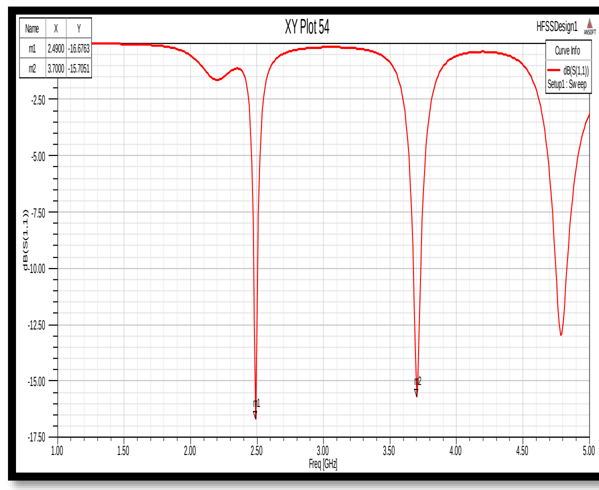


Fig-6 (A) 3rd Iteration Of Sierpinski Carpet Fractal Patch Antenna For Multi Band Frequency Response At 2.49 Ghz,And 3.70Ghz.

Similarities And Centrosymmetry Of The Fractal Shapes. The Main Advantages Of The Proposed Method Are: (1) Great Size Reduction Achieved (More Than 4 Times), (2) The Radiation Patterns Maintained, (3) Wider Operating Frequency Bandwidth Achieved, (4) No Vias To The Ground, And (5) Easiness Of The Design Methodology. To The Best Of Our Knowledge, This Is The Most Effective Technique Proposed For The Miniaturization Of Microstrip Patch Antennas So Far. The Small-Size Patches Derived From This Technique Can Be Used In Integrated Low-Profile Wireless Communication Systems Successfully.

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REFERANCES

[1] R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon. *Microstrip Antenna Design Handbook*. 2nd ed. Norwood, Massachusetts: Artech House, 2001.

[2] V. Rathi, V., G. Kumar, and K. P. Ray, ª*Improved coupling for aperture coupled microstrip antennas*,º *IEEE Trans. Antennas Propagat.*, vol. 44, no. 8, pp. 1196- 1198, August 1996.

[3] W. L. Stutzman, and G. A. Thiele. *Antenna Theory and Design*. 2nd ed. New York: John Wiley & Sons, 1997.

[4] C. A. Balanis, *Antenna Theory*, 3rd ed. New York: John Wiley & Sons Inc., 2005. 74.

[5] K. L. Lau, K M. Luk, and D. Lin. #*A wide-band dual-polarization patch antenna with directional coupler*.# *IEEE Antennas and Wireless Propagation Letters*, vol.1, pp 186-189, 2002.

[6] K. M. Luk, C L. Mak, R Chair, H Wong, and K F. Lee. #*Microstrip antennas, broadband*.# *Encyclopedia of RF and Microwave Engineering*. 6 vols. New York: John Wiley & Sons Inc, 2005.

[7] Volakis, John L., *Antenna Engineering Handbook*, 4th ed. New York: McGraw-Hill, 2007.

[8] C. Borja, G. Font, S. Blanch and J. Romeu, ª*High directivity fractal boundary microstrip patch antenna*,º *IEEE Electronics Letters*, vol. 36, no. 9, pp. 778-779, April 2000.

[9] *HFSS v13*. Computer software. Ansoft, LLC, 2011.

[10] P. S. Hall, ª*Probe compensation in thick microstrip patches*,º *IEEE Electronics Letters*, vol. 23, no. 11, pp. 606-607, May 1987.

[11] 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.

[12] G.P. Cherepanov, A.S. Balankin, and V.S. Ivanova, "*Fractal fracture mechanics*," *Engineering Fracture Mechanics*, vol. 51, pp. 997-1033, 1995.

[13] A.E. Jacquin, "Fractal image coding: A review," *Proc. IEEE*, vol. 81, pp. 1451-1465, 1993.

[14] B. Wohlberg and G. DeJager, "Review of the fractal image coding literature," *IEEE Trans. Image Processing*, vol. 8, pp. 1716-1729, 1999.

[15] M.F. Barnsley and L.P. Hurd, F*ractal Image Compression*, Wellesley, MA: A.K. Peters, 1993.

[16] A. Lakhtakia, N.S. Holter, V.K. Varadan, and V.V. Varadan, "*Self-similarity in diffraction by a self-similar fractal screen*," *IEEE Trans. Ant. Propagat*, vol. 35, pp.

[17] D.H. Werner, P.L. Werner and K.H. Church, "*Genetically engineered multiband fractal antennas*," *Electron. Lett.*, vol. 37, pp. 1150-1151, 2001.

[18] X. Liang and. M.Y.W. Chia, "*Multiband characteristics of two fractal antennas*, *Microw. & Opt. Technol. Lett.*, vol. 23, pp. 242-245, 1999.

[19] P. Tang and P. Wahid, "*Scaling property of Koch fractal dipole*," IEEE AP-S Inter. Symp. 2000, Vol. 3, pp. 150-153, 2001.

[20] D.H. Werner, P.L. Werner K.H. Church, J.W. Culver, and S.D. Eason, "*Genetically engineered dual-band fractal antennas*," IEEE AP-S Inter. Symp. 2001, Vol. 3, pp. 628-631, 2001.