International Journal of Electronics, Communication & Soft Computing Science and Engineering
ISSN: 2277-9477, Volume 3, Issue 6

WLAN Multiband Carpet Fractal Geometrie Antenna for 5 to 9 Ghz

Alok Dwivedi **Sumit Dubey** **Anil Mishra**

Abstract—**Modern communication system require antenna with wider bandwidth, smaller dimension, high gain and high efficiency. Various antennas for wide band operation have been studied for communication and radar system. The use of fractal geometry in designing antenna has been a recent topic of interest. Fractal antenna is preferred due to small size, light weight and easy installation. The proposed antenna has been simulated and optimized using IE3D Simulator to cover standard frequency bands like UWB at (6GHz,9.061GHz), ISM/WLAN/Bluetooth band (Operating freuencuies:2.32GHz), Wi-Max (3.4-3.69)GHz, Operating Frequencies: 3.54GHz), HiperLan4(8.5) communication.**

Keywords- **IE3D; FR-4 substrate, WLAN Application;**

I. INTRODUCTION

Recently, the wireless communication technology is developed rapidly; So that we introduced Microstrip patch antennas (MPA) have the advantages compared to the traditional microwave antennas such as low profile, light weight, easy fabrication and integration with other circuit elements However, it inherits narrow bandwidth and relative large size in microwave frequency range. There are several methods to obtain dual frequency, size reduction with improvement in bandwidth and gain by the use of thick substrate, cutting a resonant slot inside the patch, the use of a low dielectric substrate, multi-resonator stack configurations, the use of various impedance matching and feeding techniques, and the use of slot antenna geometry. Proposed design uses probe feeding method with slot on the patch to improve the different parameters of microstrip antenna.

II. HISTORY

A microstrip antenna was firstly introduced in 1950's but it became popular and took place in various applications in 1970's. Recently, microstrip antennas are widely used in several applications where small size, low weight and cost, high performance and easily fabricated and installed antennas are required such as air borne, space borne commercial and military applications and mobile and wireless technologies. Some other advantages of microstrip antennas are that they are conformable to planar and non-planar surfaces, easily fabricated using printed circuit technology, and they are mechanically robust. Microstrip patches are resonant type antennas.

Literature Survey

I have gone through many international papers and publications which helped me understand the concepts of the microstrip patch antenna their utility and gave me a clear view of the goals and challenges that lie ahead in designing this antenna in a practically realizable way.

It is focusing on various types of fractal geometry antenna uses for multiband application. Various fractal geometry antennas represent the multiband applications.

1. Homayoon Oraizi and Shahram Hedayati "Miniaturized UWB Monopole Microstrip Antenna design by the Combination of Giuseppe Peano and Sierpinski Carpet Fractals" IEEE Antenna and Wireless Propagation Letter, vol.-10,no.-,pp.67-70.2011

A fractal monopole antenna is presented for the application in the UWB frequency range, which is designed by the combination of two fractal geometries. The first iterations of Giuseppe Peano fractal are applied on the edges of a square patch, and a Sierpinski Carpet fractal is formed on its surface. The feed circuit is a microstrip line with a matching section over. The presented C antenna has an Omni-directional radiation pattern, a good gain, and high efficiency. [1]

III. PROBLEM IDENTIFICATION

In literature survey I discussed various fractal geometry were applied for the design and realization of frequency-independent and multiband antennas. Multiplication of an antenna size by a factor generally decreases the operating frequency of the antenna by the same factor. If an antenna is much smaller than the wavelength of the operating frequency, its efficiency deteriorates drastically since its radiation resistance decreases and the reactive energy stored in its near field increases. These two factors make the matching of a small antenna to its feeding network difficult. Consequently, fractal antennas are a viable candidate for their miniaturization. Antenna geometries and dimensions are the main factors determining their operating frequencies.[5] In order for an antenna to work equally well at all frequencies, it must satisfy two criteria: it must be symmetrical about a point, and it must be self-similar, having the same basic appearance at every scale: that is, it has to be a fractal

Proposed fractal geometry

In this dissertation, I design two fractal antennas one by using single layered and second by fractal geometries implemented on multilayer using air gap.

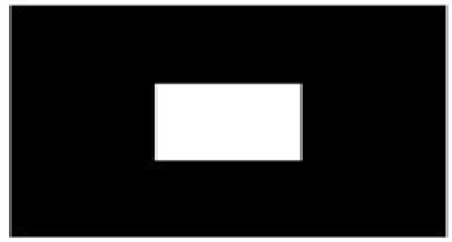
a. Fractal Antenna

Sierpinski carpet geometry is the most widely studied fractal geometry for antenna applications. This has been investigated extensively for monopole and dipole antenna configurations [17]. It has been found that by perturbing the geometry the multi-band 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 the antenna. Antennas using this geometry have their performance closely linked to conventional bow-tie antennas. However some minor differences can be noticed in their performance characteristics.

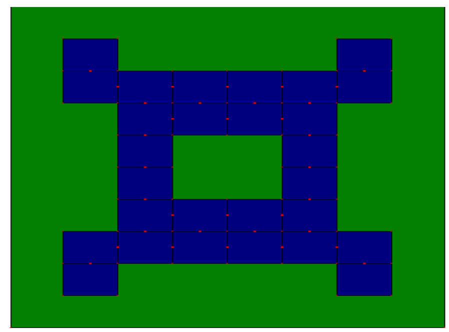
The Sierpinski carpet fractal is generated by geometric transformations on squares. Sierpinski Carpet fractal antenna can realize by applying successive iteration on square patch as shown in Figure 4.1(a). The 0th iteration is resulted by a simple rectangular patch. Here, the dimension of square is equal to one third of the main patch is subtracted from the center of patch to retrieve first order iteration as shown in Figure 4.1 (b).The next step is to each squares which are nine time and twenty seven time smaller than the main patch as shown in Figure 4.1 (c) and (d) respectively.

The second and third are carried out eight times and sixty four time 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 define in such a way that each consequent etched square in one third dimension as compared to previous one sharing the same center point. The self-similar current distribution on these antennas is expected to cause its multi-band characteristics [18].

Stage 1 (1st iteration)



(b) Stage 2 (2nd iteration)



(c) Stage 3 (3rd iteration)

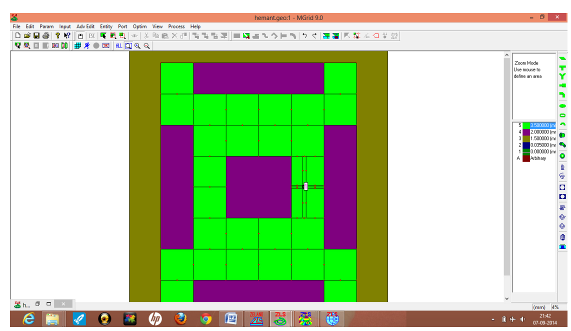


Fig. 4.1 Construction of Sierpinski Carpet Fractal geometry

IV. Design And Simulation Result For Multilayer Structure

Steps required for calculating width (W) and Length (L) of microstrip antenna

Step 1. Initially, select the desired resonant frequency, thickness and dielectric

Constant of the substrate.

Step 2. Obtain Width (W) of the patch by inserting εr and $\lambda 0$.

Step 3.Obtain Length (L) of the patch after determining ΔL and εr.

The three essential parameters for the design of a rectangular Microstrip Patch Antenna:

Frequency of operation (fo): The resonant frequency of the antenna must be selected appropriately. The Mobile Communication Systems uses the frequency range from 2100-5600 MHz Hence the antenna designed must be able to operate in this frequency range. The resonant frequency selected for my design is 2.4 GHz.

Dielectric constant of the substrate (εr): The dielectric material selected for our design is FR4 which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna.

Height of dielectric substrate (h): For the Microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as1.5 mm.

Hence, the essential parameters for the design are:

fo= 2.4 GHz $\varepsilon_r = 4.4$

h = 1.5 mm

Simulation Setup The software used to model and simulate the Microstrip patch antenna is ZelandInc's IE3D. IE3D is a full-wave electromagnetic simulator based on the method of moments. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, wire antennas, and other RF/wireless antennas. It can be used to calculate and Return loss plot, VSWR, current distributions, radiation patterns etc. For design simplicity of the conventional MSA, the patch's length and width are shows in the table 5.2. Here two different geometry fractal antenna simulated and observe all antenna parameters like Return loss plot, VSWR, radiation patterns, Directivity, Gain and efficiency. Then compare both result and investigated advantages of applying Sierpinski carpet.

The Inset feed used at point (8, 0) to design the rectangular patch antenna. The center frequency is selected as the one at which the return loss is minimum. The bandwidth can be calculated from the return loss (RL) plot. The bandwidth of the antenna is said to be those range of frequencies over which the return loss is below than -7.5 dB. The Implemented Sierpinski carpet antenna simulated return loss data and its operating frequency are as shown figure.

a. Return Loss Plot for Ist Iteration

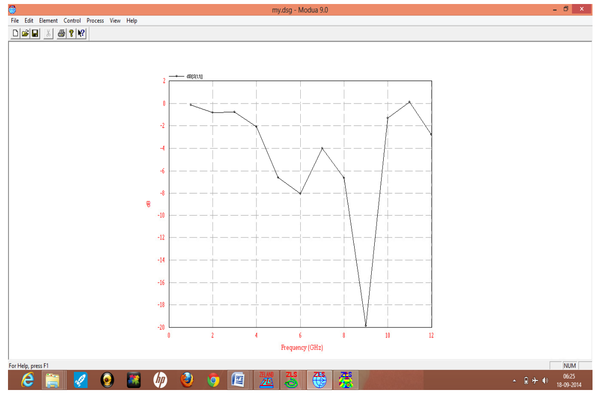


Fig. (a) Return Loss Graph of Carpet single layer Antenna

b. Return Loss Plot for 2nd Iteration

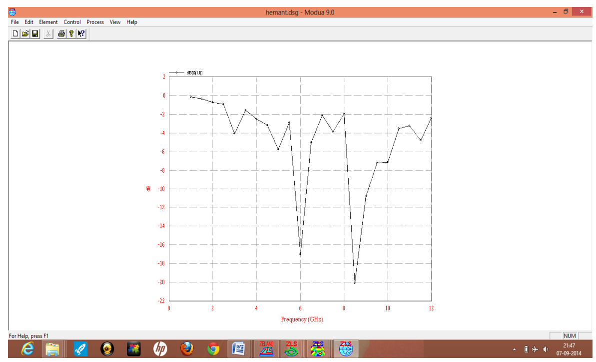


Fig. (b) Return Loss Graph of 2nd Iteration Sierpinski Carpet Antenna

c. Return Loss Plot for 3rd Iteration

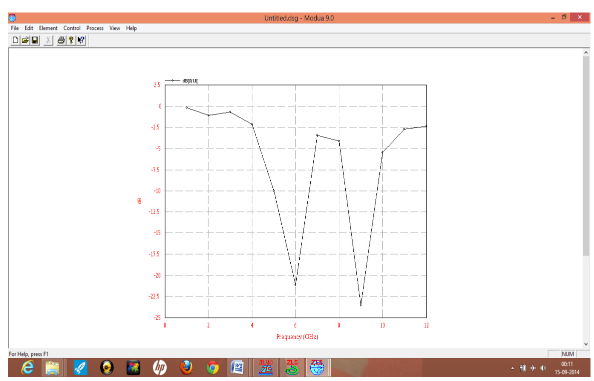


Fig. (c) Return Loss Graph of Carpet multilayer Antenna

VSWR Plot of carpet multilayer antenna

Voltage standing wave ratio (VSWR) of proposed Carpet multilayer Antenna
shown in figure.

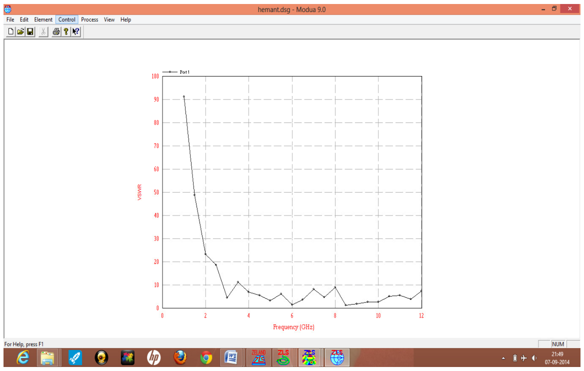
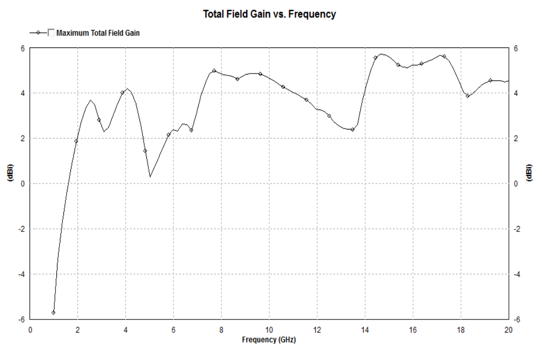


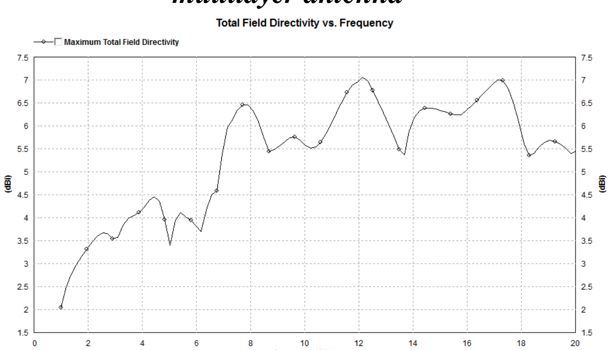
Fig (d)VSWR Plot of Carpet Antenna

Gain vs. Frequency Plot



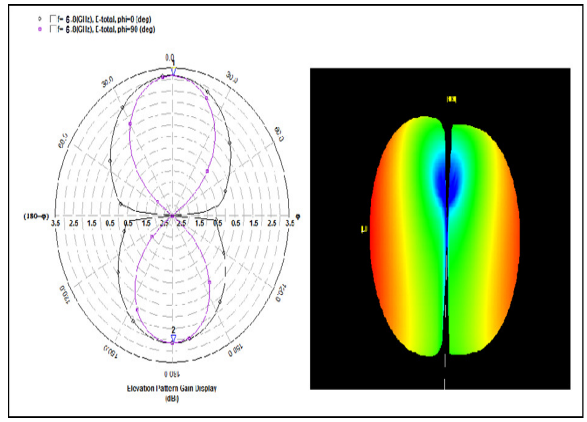
Gain vs. Frequency Plot of carpet multilayer Antenna

Directivity vs. Frequency Plot of carpet multilayer antenna

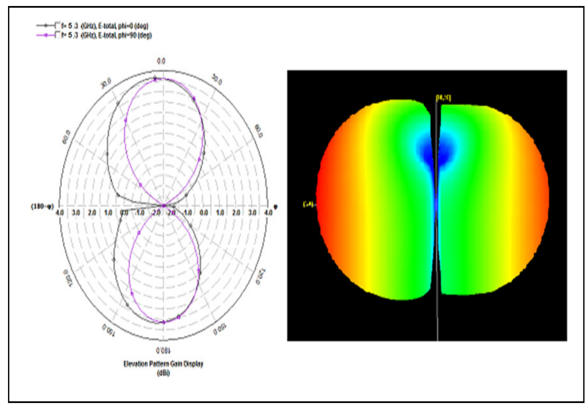


The gain of an antenna is essentially a measure of the antenna's overall efficiency. If an antenna is 100% efficient, it would have a gain equal to its directivity. Shown in figure.

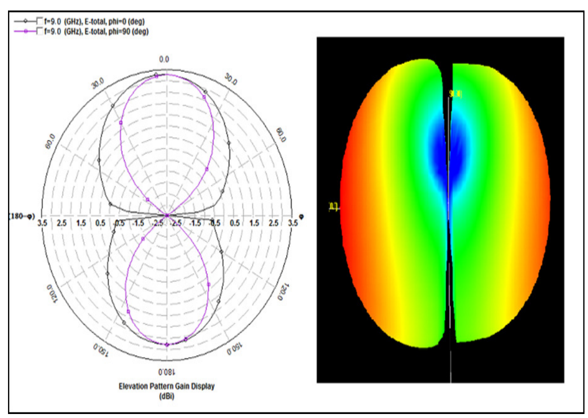
Radiation pattern for 6 GHz



For 5 GHz frequency.



For 9 GHz frequency



See the figure represents 2D radiation pattern and 3D radiation pattern respectively.

V. CONCLUSION

This Paper work presents new concept of implementation of Fractal geometry on multilayer Sieperinski Carpet fractal geometry and designed multiband antenna.The aim of this paper work is to find how implementation Sieperinski Carpet fractal geometry on multilayer gives better result in achieving antenna parameters like return loss (RL),VSWR, antenna efficiency ,Gain, directivity and bandwidth. In this paper work I first design multiband Carpet fractal microstripe patch antenna and simulate its results with IE3D software. I find that as iteration increases, there is increase in number of bands. Hence fractal geometry is a used to obtain multiband application antennas but after more than 3rd iteration system.

REFERENCES

[1] Homayoon Oraizi ,Senior Member, IEEE and Shahram Hedayati," Miniaturized UWB Monopole Microstrip Antenna Design by the Combination of Giuseppe Peano and Sierpinski Carpet Fractals" IEEE Antenna and Wireless Propagation Letter, vol.-10,no.-,pp.67-70.2011.

[2] Homayoon Oraizi, Senior Member, IEEE and Shahram Hedayati," Miniaturization of Microstrip Antennas by the Novel Application of the Giuseppe Peano Fractal Geometries" IEEE Transaction on Antenna and Propagation, vol.- 60, NO. 8, pp.3559-3567 August 2012.

[3] Kin-Lu Wong, Senior Member, IEEE, Gwo-Yun Lee, and Tzung-Wern Chiou, "Low-Profile Planar Monopole Antenna for Multiband Operation of Mobile Handsets",IEEE Transaction on antenna and propagation, vol.- 51. No.- 1, pp. 121-125.January 2003.

[4] Eko Tjipto Rahardjo, Fitri Yuli Zulkifli and Desi Marlena,"Multiband Microstrip Antenna Array for WiMAX Application", Microwave Conference, 2008, APMC2008; Asia-Pacific, Year: 2008, PP:1– 4. ISBN 978-1-4244-2642-3.

[5] Douglas H. Werner', Randy L. Haupt ,and Pingjuan L. Werner "Fractal Antenna Engineering: The Theory and Design of Fractal Antenna Arrays" IEEE Antennas and Propagation Magazine, vol.- 41, No. 5 PP. 37-58., October I999,

[6] Abolfazl Azari, "A New Super Wideband Fractal Microstrip Antenna" IEEE Transaction on Antenna and propagation, vol.- 59, no. 5, 1724-1727 MAY 2011. ISSN 0018-926X.

[7] B. R. Franciscatto ,T. P. Vuong and G. Fontgalland, " High gain Sierpinski Gasket fractal shape antenna designed for RFID", Microwave & Optoelectronics Conference (IMOC), SBMO/IEEE MTT-S International.PP.239-243,2011. ISBN978-1-4577-1662-1.

[8] Leonardo Lizzi,Andrea Massa," Dual-Band Printed Fractal Monopole Antenna for LTE Applications", IEEE Antennas and wireless propagation letter, vol.- 10, PP. 760-763. 2011.

[9] AsitK.Panda, ManojK. Panda and SudhansuS. Patra "A Compact Multiband Gasket Enable Rectangular Fractal Antenna" International Conference on Computational Intelligence and Communication Systems.PP.11-14. 2011 ISBN 978-1-4577-2033-8.

[10] Homayoon Oraizi, Senior Member, IEEE and ShahramHedayati, "Circularly Polarized Multiband Microstrip Antenna Using the Square and Giuseppe Peano Fractals" IEEE Transactions on antenna and propagation, vol. - 60, NO. 7, PP.3466 -3470. July 2012.

[11] Ashish A. Lale, Bhagwan V. Khiste and Sanjay Khobragade, "Study of Sierpinski triangle gasket" Microwave & Optoelectronics Conference (IMOC),SBMO/IEEE MTT-S International.vol.- 3,PP 386-390,2011 ISBN 978-1-4244-8679-3.

[12] L. S. Araújo, C. P. does Nascimento Silva, L. C. Barbosa, A. J. Belfort de Oliveira, "A novel Sierpinski carpet fractal dipole," Microwave & Optoelectronics Conference (IMOC), SBMO/IEEE MTT-S International.PP960—967, 2011.ISBN 978-1-4577-1662-1.

[13] Muhammad Waqas, Zubair Ahmed, Mojeeb Bin Ihsan, "Multiband Sierpinski Fractal Antenna" Multi topic Conference. INMIC 2009. IEEE 13th International.PP.1-6, 2009 Print ISBN 978-1-4244-4873-9.

[14] Keng-Chih Lin, Chih-Hao Lin, and Yi-Cheng Lin "Simple Printed Multiband Antenna with Novel Parasitic-element Design for Multi-standard Mobile Phone Applications" IEEE Transaction on Antenna vol.- 61,Isuee 1,2012 PP.488-491.

[15] Steven R. Best, "A Multiband Conical Monopole Antenna Derived From a Modified Sierpinski Gasket", IEEE Antennas and Wireless Propagation Letters, vol.- 2,PP. 205-207.2003

[16] Duixian Liu and Brian Gaucher "A New Multiband Antenna for WLAN/Cellular Applications", IEEE Antennas and Propagation Magazine, vol.-1, no.4, August2011.PP 243-246,ISSN 1090-3038

[17] David Pozar "Microstrip Antennas" Published in Antennas and propagation IEEE Transactions on vol.45 issue 2, pp. 287-296. 1997, ISSN 0018-926X.

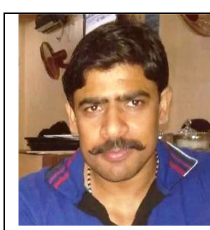
[18] Tian Tiehong, Zhou Zheng, "A Novel Multiband Antenna: Fractal Antenna", International conference , Proceedings of ICCT vol.-2 issue 1pp. 1907-1910.2010

[19] Qi Luo, J.R.Pereira and H.M.Salgado, "Tunable Multiband Antenna with an Active Artificial Magnetic Conductor Ground Plane", Microwave Conference (EuMC), 2010 European, Year: 2010, PP: 461 – 464, Print ISSN 978-1-4244-7232-1.

[20] Philip Tang and Parveen Wahid, "Hexagonal Fractal Multiband Antenna "The IEEE Transaction on Antenna, vol.-4, pp.554-5571997.ISBN 0-7803-7330-8.

AUTHOR'S PROFILE

ALOK DWIVEDI
M.Tech Student[EC]
JNCT, REWA
rewa.alok@gmail.com
Has done B.E(ECE) in 2011 & is currently pursuing M.Tech. in Electronics & Communication under the guidance of asst. professor Sumit Dubey from JNCT, Rewa affiliated to RGPV, Bhopal



SUMIT DUBEY
Asst. Proff., EC Department
JNCT, REWA
mtech.sumitdubey02@gmail.com
Has done B.E. & M.Tech. From DAV (Indore). He is currently assistant professor in Electronics & Communication department of JNCT, Rewa. He has teaching experience of more than 4 years

ANIL MISHRA
HOD, EC Department,
DEAN ACADEMIC
JNCT, REWA
anilmishraec@gmail.com

Has done B.E., M.Tech. & is currently pursuing P.H.D. He is currently Dean Academic of JNCT, Rewa. He is also the H.O.D. of Electronics & Communication department in JNCT, Rewa. He has teaching experience of more than 5 years