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Review on Design of Multiband Antenna Using Different Type of Fractal Geometry for UWB Application

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Abstract :- In many applications such as with antennas on ships, aircraft, large spacecraft etc. demand for antennas,which are capable to be embedded in portable, devices which serve a wireless land mobile or terrestrial-satellite network. With time and requirements, these devices become smaller in size and hence the antennas required for transmit and receive signals have also to be smaller and lightweight. So fractal antenna is good solution for these requirements. Fractal geometry is simple and effective method to reduce antenna size with multiband performance. This paper gives review on design of multiband fractal antenna using different type of fractal geometry for UWB application.

Keywords :- Fractal Geometry, multiband, monopole antenna, UWB.

I. INTRODUCTION

Antenna is the part of an electromagnetic system that either transforms energy from current and voltage into electromagnetic radiation or vice versa. Previously, antennas operate only for dual or triple band of frequencies. But for commercial and military telecommunication systems require ultra wide band antennas. Which have small physical size and multi-band capability are very important in the design of ultra wide band antennas. Fractal geometry is a very good solution to fabricate multi-band and low profile antennas. Applying fractals to antenna elements allows for smaller size, multi-band and broad-band properties. Thus, this is the cause of spread research on fractal antennas in recent years [1]–[5].Fractals have self-similar shapes and can be subdivided in parts such that each part is a reduced size copy of the whole. The self-similarity of fractals is the cause of multi-band and broad-band properties and their complicated shapes provides design of antennas with smaller size. Fractals have convoluted and jagged shapes such that these discontinuities increase bandwidth and the effective radiation of antennas. The space-filling property of fractals leads to curves which have long electrical length but fit into a compact physical volume. Several UWB antenna configurations based on fractal geometries have been investigated including Koch, Sierpinski, Minkowski, Hilbert, Cantor, and fractal tree antennas in recent years. The numerical simulation and experimental results of these antennas are available in literature_to date. In this communication, a fractal microstrip antenna is presented. So far, for size reduction, bandwidth enhancement, multiband performance, numerous fractal geometry antennas have been proposed by using fractal geometry.

II. BRIEF INTRODUCTION OF CONTRIBUTED PAPERS

Antenna Design, simulation and measurement.

2.1 Multiband Sierpinski Fractal Antenna [1]

In this paper, a fractal monopole antenna based on the Sierpinski gasket proposed. The monopole antenna based on the Sierpinski gasket constructed through three iterations displays a multiband behavior with three bands that are log periodically spaced by a factor of 2, the same scale factor that defines the geometrical self-similarity of the Sierpinski fractal. The simulated as well as measured input return loss and radiation patterns all display multi-band behavior. The geometrical scale factor of the Sierpinski fractal is then changed to see whether the bands are shifted according to the new scale factor or not. The simulated results showed that the band positions could be controlled by changing the scale factor but on account of poor input matching. This poor input matching of Sierpinski fractal monopole antenna with modified scale factor is rectified using microstrip feed technique.

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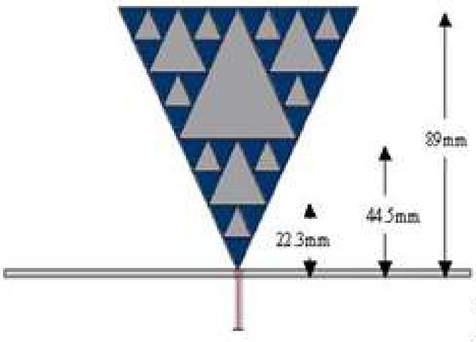


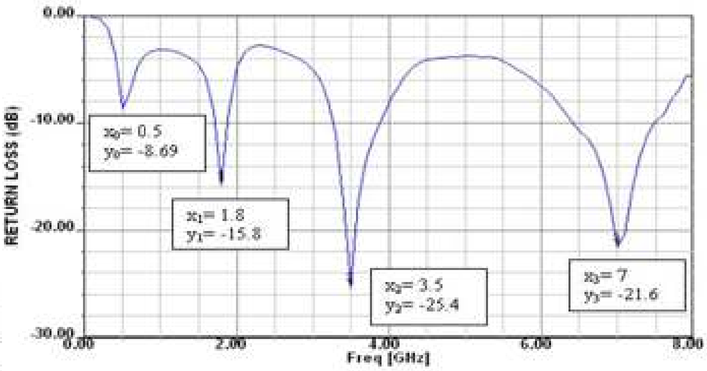
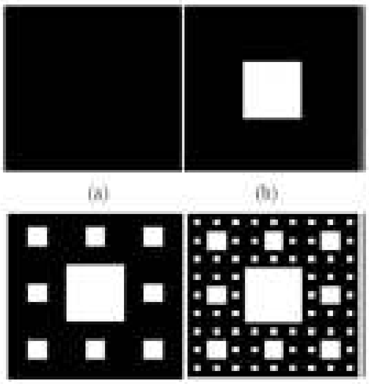


Fig.1 Antenna design **Fig.2 Simulated Return Loss**

Simulated result shows that proposed antenna gives three log-periodic bands that is 1.8GHZ, 3.67GHZ, 7.5GHZ consist gain 4.9dBi, 6.6dBi, 7dBi.

2.2 Design and Implementation of Sierpinski Carpet Fractal Antenna for Wireless Communication [2]

This paper presents the design of Sierpinski carpet fractal antenna up to third iteration. The proposed antenna is designed on FR4 substrate with dielectric constant of 4.4 and fed with 50 ohms microstrip line. By optimizing the width microstrip feed and its location the antenna can be optimized to operate in multiple bands between 2-14GHz.



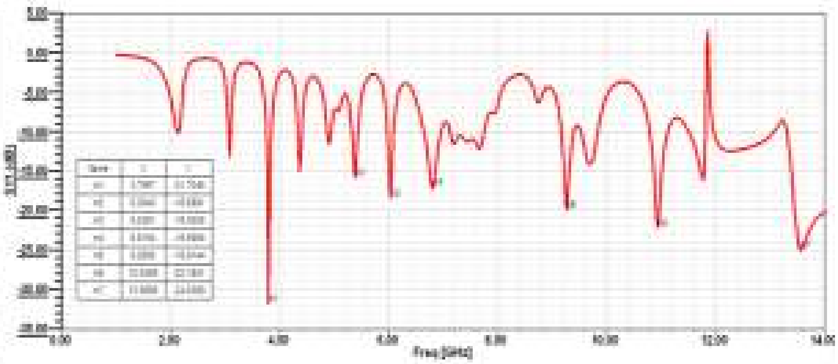
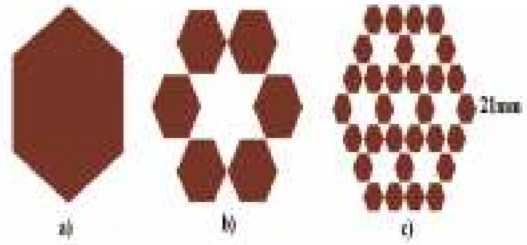


Fig 3. Proposed antenna design **Fig 4. Return Loss**

The simulated result shows the design the Sierpinski carpet antenna, has been simulated by varying two parameters, (i) position of the feeding line from the edge of the substrate. (ii) Width of the microstrip feed. By selecting these parameters, the proposed antenna can be tuned to operate within the frequency range 2GHz –14 GHz.1st iteration of Sierpinski carpet microstrip antenna (SCFA) analysis is carried out by varying the feed location and the width of the microstrip feed line. The design of 2nd iteration SCFA which is obtained by further inserting slots 1/3 times that of the center slot. The design of 3rd iteration of SCFA which is obtained by further inserting slots 1/3 times that of the slots in 2nd iteration. As iterations goes on we get excellent deep return loss measurements.

2.3 A Hexagonal Fractal Antenna for Multiband Application [3]

This paper describes the concept of a new fractal multi-band antenna based on the hexagon shape. Three iterations of the hexagonal fractal multi-band antenna arranged are examined. With this structure it is possible to configure the multi-band frequency and radiation pattern to obtain directional patterns with high directivity and gain. The ADS software was used to design and analyze the antenna array for applications at range 0.5-10GHz.Fabrication of the antenna is done by using wet-etching method, on FR-4 dielectric.



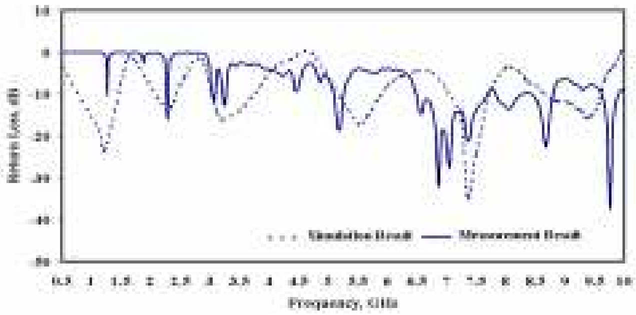
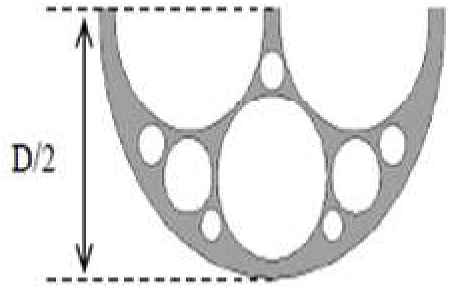


Fig 5. Configuration of proposed antenna **Fig 6. Return loss of proposed antenna**

The simulated result shows the Hexagonal fractal Antenna produced a high return loss compared to the Sierpinski Carpet Fractal Antenna. The higher return loss is at -37.65 dB for 9.763 GHz. Hexagonal Fractal antennas produced a larger E-plane than the H-plane. On the E-plane, the patterns of azimuth (x-y) plane are symmetrical. The patterns on the H-plane are almost Omni-directional, thus, extremely suitable for applications in mobile communication devices.

2.4 **Modified Half-Circle Fractal Antenna Using DC Theorem for 2.4/5.2 GHz WLAN Application [4].**

In this paper, A new form of modified CPW-fed half circle fractal patch antenna is proposed for dual band 2.4/5.2 GHz Wireless Local Area Network (WLAN) application. The circular shape antenna based on the Descartes Circle (DC) theorem and iteration of self similar design. The -10 dB return loss (VSWR2:1) impedance bandwidth in 2.4 GHz band is 28% and it covers the required bandwidth for 2.4 GHz WLAN. The 5.2 GHz resonant mode has impedance bandwidth of 40% covering 5.2/5.5/5.8 GHz WLAN bands. The EM characteristics of the antenna are presented by the current distribution. Proposed antenna maintained good radiation patterns with gain.



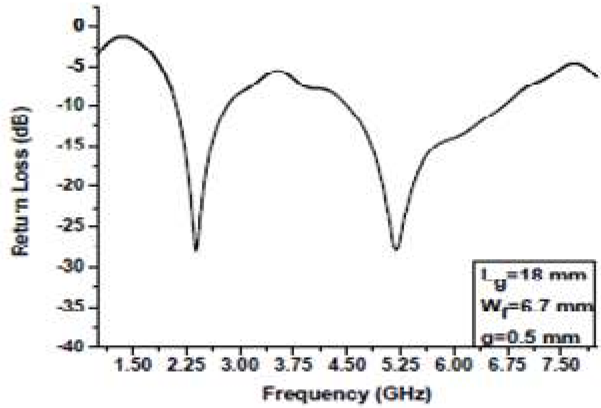


Fig 7. Design of proposed antenna. Fig 6. Return loss of proposed antenna

The simulated result shows the proposed antenna is resonating at two frequencies. For first frequency -10 dB impedance bandwidth is from 2 GHz to 2.85 GHz with resonance at 2.4 GHz and the second frequency -10 dB impedance bandwidth is from 4.5 GHz to 6.6 GHz with resonant at 5.2 GHz. Both resonating frequencies cover the IEEE standard 802.11b/g and 802.11 a, 2.4/5.2 GHz WLAN. The gain across the lower band of 2.4 GHz is ~3dBi and for higher band of 5.2 GHz is ~4dBi. The antenna gain is well matched in both the frequencies. Proposed antenna resonating in broad side direction at V=0° and V=90° at 2.4 GHz and 5.2 GHz frequencies. The results show very monopole like radiation pattern with omnidirectional radiation.

2.5 **Design of Fractal UWB Antenna [5].**

In this paper, Design of a miniature coplanar waveguide (CPW) fed Wideband Antenna is presented. This antenna consists of a fractal radiator, which has multiple resonances and CPW ground plane which are used to extend the bandwidth and reduce the overall size of this antenna. Measured results show that this antenna operates from 6.2 to 10.0 GHz and has relatively stable radiation patterns over its whole operation band. This antenna also has a very compact size, only 29 × 24 mm2. Further tuning of fractal parameters may give operation in UWB.

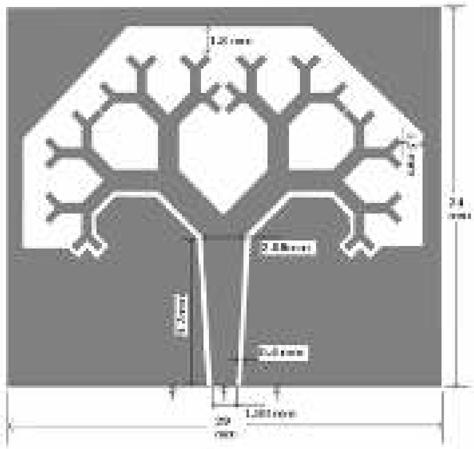


Fig 9. Configuration of proposed antenn

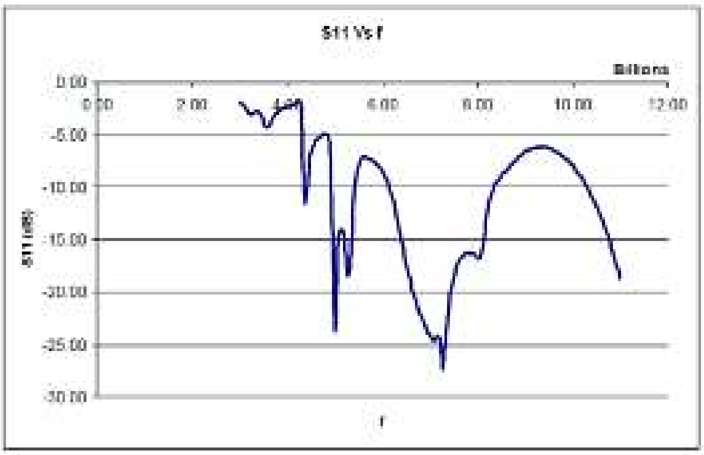


Fig 10. Return loss of proposed and reference antenna

This curve shows that the antenna maintains 10- db bandwidth is from 6.2 GHz to 6.8 GHz and 7.5-8.2 GHz and 8.5-10 GHz. This can be approximated as 6.2 to 10 GHz bandwidth because by tuning some variables it is quite easy to achieve the same. The gain of the antenna is less than 0 db at almost all the angles, which proves omnidirectional characteristics.

III. COMPARISON TABLE FOR SURVEY PAPER

Paper	size(mm2)	Substrate	Type of feeding technique	Frequency GHz	Gain(dBi)	Return losses(dB)
1	300 x 300	FR4 Substrate	Co-axial Cable	1.8, 3.67, 7.5	4.9, 6.6, 7	Bellow than -25dB
2	28 x 37	FR4 Substrate	Microstrip line	2 to 14	1.23,2.68,3.31,3.83	Bellow than -30 dB
3	54.53 x 80.1	FR4 Substrate	Co-axial Cable	0.5 to 10	1.32,3.62,4.88, 5.55,5.9,6.5	Near about -34.80 dB
4	6.7×19	FR4 Substrate	CPW fed microstrip line	2.4/5.2	lower band of 2.4 GHz is ~3dBi, Higher band of 5.2 GHz is ~4dBi.	Near about -30dB
5	29 x 24	FR4 Substrate	CPW	6 to 10 UWB	Less than 0 db almost all angles	Bellow than -25dB

IV. CONCLUSION

This paper gives review of different fractal geometry which are used to obtained multiband or multi frequency operation suitable for UWB application. From the study of different paper the conclusion is, fractal geometry is simple solution to achieve multiband frequency behavior with reduced antenna size. This antenna structure provides good radiation pattern with high directivity and gain, when compared to simple patch antenna. As well as return loss measurements show an excellent deep with suitable bandwidth.

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