Design and Analysis of a Crown Shaped Fractal Antenna and Slotted Octagonal Shaped Fractal Antennas

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Abstract

This paper presents the design of a multiband fractal antenna that have been designed, simulated and results verified through VNA-Network analyzer .Observations are made on the sundry antenna parameters such as return loss. VSWR radiation pattern input impedance etc. in all the proposed cases. From the results of the simulation/quantified, it has been observed that the influencing parameters of the antenna are the efficacious electrical length of antenna, space filling characteristic curve and scale factor while proceeding from lower iteration to higher iteration along with the victual location, the position of the parasitic patch (in the multiband case), and the length and width of the patch.
Keywords: Fractal Antennas, VSWR, VNA, Wireless Communication

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I. INTRODUCTION

The fractal antennas are also referred as multilevel and space filling curve. Basically these are the state of affairs for research action.

The fractal antenna engineering research is an advance and very recent advance technology because considerable computing speed is required to complete antenna design. In the research journals, we see reports of active research covering such diverse of Fractal use in antenna field and their advantages. Fractal are self-similar objects and possess structure at all scales. Fractal geometries have found intricate place in science as a representation of some of the unique geometrical features occurring in nature.

Benoit Mandelbrot had first discovered of fractal geometry as a way to mathematically whose dimension cannot be limited to whole numbers.

Benoit Mandelbrot classified this geometry first time and gave the term fractal in the year 1975 which was derived from a Latin word i.e. fractus, “Fractus” meaning broken. The domain is literally wide from natural modeling, statistical analyses, computer graphics, compression and, of course Falconer et.al 1990. Anon after scientists verbally expressed work on fractal geometry and discovered some practical aspect about fractal geometry. Rudiment ally there have been applied more efforts aimed at the physical phenomenon and strands of mathematical basis of interaction between electromagnetic waves and dome of multilevel antennas or fractal antennas.

Fractal antenna are space filling contours in this away that all electrical features can be efficiently packed into narrow areas. Since the electrical lengths plays a paramount role in designing of antenna, the efficient way of the packing of electrically immensely colossal features that can be utilized as a feasible miniaturization advance technique Gianvittorio et.al 2002. Fractals antenna has the structures of sundry intricacies with self-matched properties. Denote that as the structure is zoomed in upon, the structures of sundry intricacies with a self-matched property. Means that as the structure is zoomed in upon, the structure recurs itself. This property could be acclimated to design the antennas that can be operated at several frequencies.

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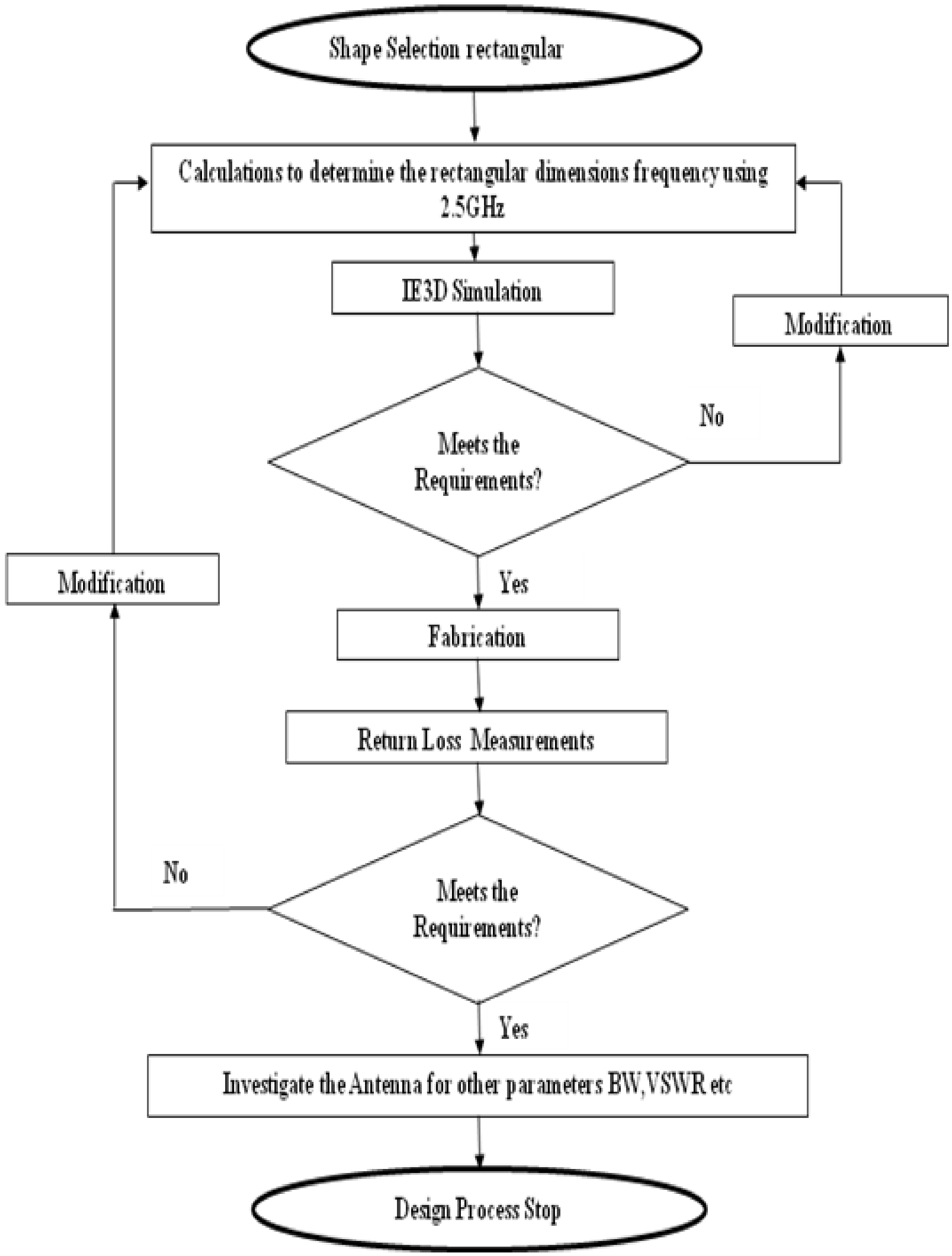

Fig. 1: Flow Chart for the Design of a Fractal Antenna

Concepts of fractal antenna can be explained by using modern geometry that is an extension of fractal geometry. The space occupied by the antenna if it is filled by a fractal antenna it will be the more effective way to fill in comparison of traditional Euclidean antennas. Transmission lines have free space in less volume the effective coupling from feeding of energy. Therefore, Fractals antennas can be used to improve in the designing of modern antenna. In that type of antenna the operator would allow incorporate several aspects of their system.

II. CROWN SHAPED FRACTAL ANTENNA AND SLOTTED OCTAGONAL SHAPED FRACTAL ANTENNAS

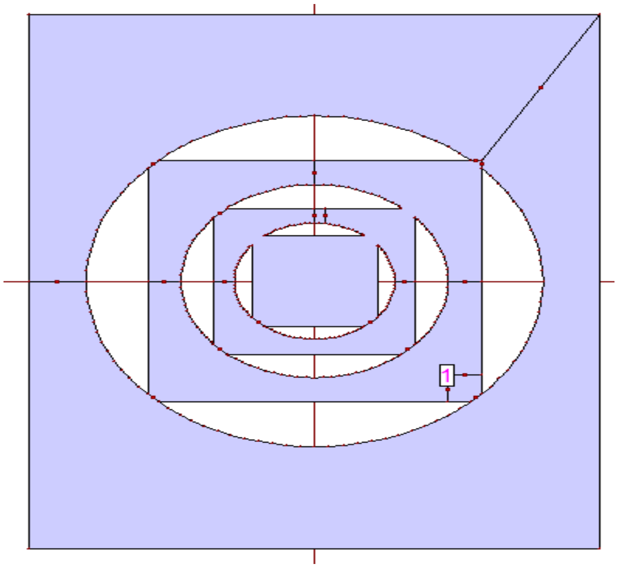

Fig. 2: Crown Shaped Fractal Antenna

The Figure 2 shows the planner view on front end window using software IE3D applied for designing the geometry of proposed antenna with proper dimensions. After completion of all simulation setup IE3D provide various antenna parameters through it's easily accessibly in user graphics format for analysis point of view.

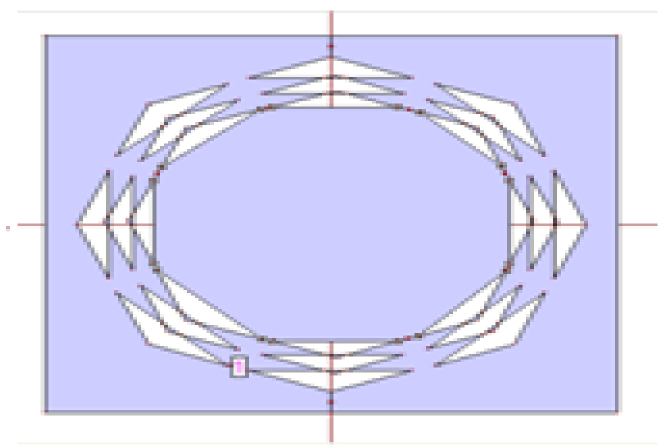

Fig. 3: Slotted Octagonal Shaped Fractal Antenna

The Figure 3 shows the planner view on front end window using software IE3D applied for designing the geometry of proposed antenna with proper dimensions.

The Crown Shaped Fractal Antenna has been proposed, constructed, and tested for wireless application. The proposed antenna has iterative geometry. The proposed antenna design provides compatibility and adoptability of various frequencies ranging from 0.5 GHz up to 10GHz and provides characteristics such as 32% radiation efficiency and highly permissible gain up to 4 dB directivity up to 11dBi. The proposed antenna has good directional-radiation characteristics.

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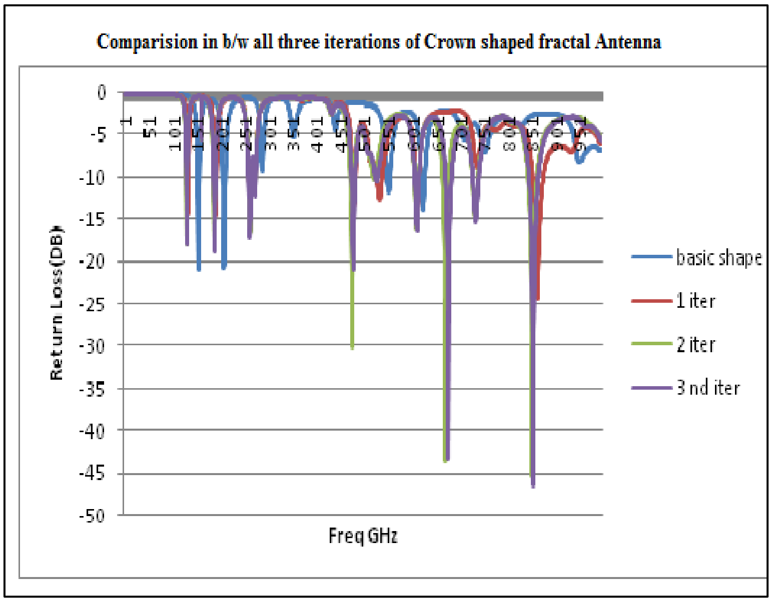

Fig. 4: Comparision Curve (Simulated) Of S11 (Db) For All Three Iteration of Crown Shaped Antenna

The Figure 4 shows the comparative analysis of all the three iteration of Crown Shaped antenna. Table 1. So from these it is quite clear that the fractal behaviour of this antenna is verified.

Table - 4.1
Comparative Analysis: Return Loss for all three iteration of Crown Shaped Antennas

Freq.	*S_{11}-3rd-Iter.*	*Freq.*	*S_{11}-2nd-Iter.*	*Freq.*	*S_{11}-1st-Iter.*
1.7	-20	1.7	-18	1.9	-20.5
2.1	-19	2.1	-19	2.5	-20.25
3	-16	3	-16	6.7	-11.5
3.1	-15	3.1	-12	6.5	-13
5	-22	5	-21		
5.5	-12	5.5	-10		
6.2	-16.5	6.2	-16		
6.9	-45	6.9	-44		
7.3	-18	7.3	-15		
8.	-47	8.5	-45		

One of the interesting observations from analysis of third iteration of this antenna obtained that this can also serve the Ka and Ku band as well .The Table 2 shows the comparison in between simulated and measured results shown in Figure 5.

Table - 2
Comparative Table in between simulated and measured results for Third Iteration of Crown Shaped antenna

S.NO.		*Resonant Frequency(GHz)*		*Simulated (Return Loss In (dB)*	*Measured (Return Loss in (dB)*
1		0		0	0
2		1		-5	-3
3		1.4		-7	-5
4		1.7		-20	-12
5		2.1		-19	-16
6		3		-16	-15
7		3.1		-15	-10
8		5		-22	-20
9		5.5		-12	-22
10		6.2		-16.5	-18
11		6.9		-45	-40
12		7.3		-18	-10
13		8		-47	-40

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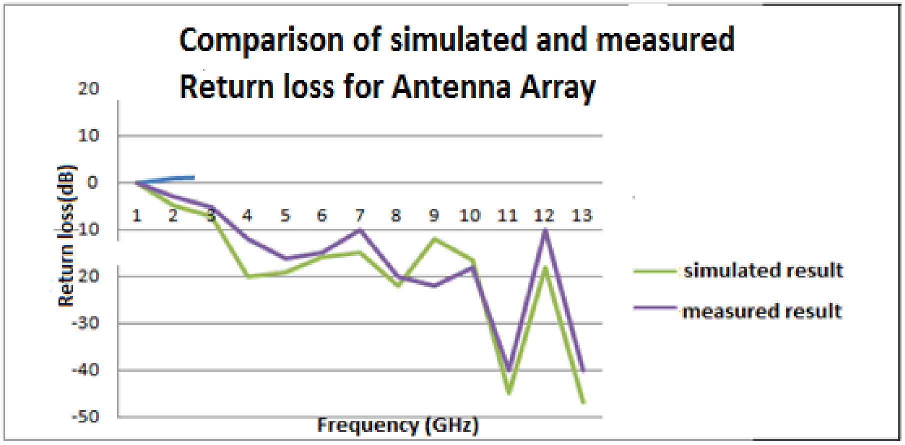

Fig. 5: Comparison curve between measured and simulated return loss for fabricated Crown shape Fractal antenna
Slotted Octagonal Shape antenna

The Complementary Slotted Octagonal Shaped fractal antenna has been proposed, designed and tested. The particular antenna has simple iterative geometry. As the proposed antenna design provides adoptability of various frequency ranging from 0.5 GHz up to GHz and provides characteristics such as 24% radiation efficiency and highly permissible gain up to 3dB directivity up to 11.5 dBi. The proposed antenna has good directional-radiation characteristics.

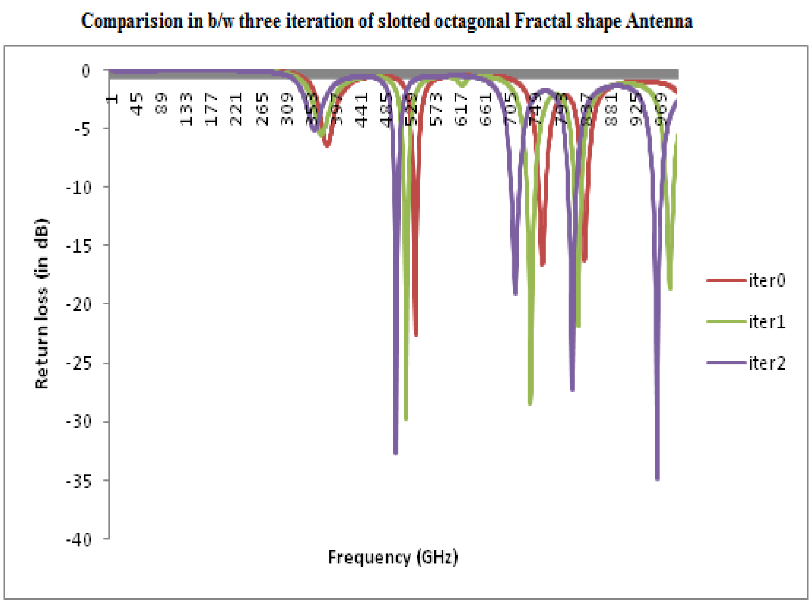

Fig. 6: Comparision Curve (Simulated) Of S11 (Db) For All Three Iteration of Complementary Slotted Octagonal Antenna

Figure 6 shows the comarative analysis of all the three iteration of Complementary Slotted Octagonal antenna , Table 3.So from these it is quite clear that the fractal behaviour of this antenna is verified.Table 4.4 shows the comparision in between simulated and measured results shown in Figure 7.

Table – 3
Comparative Analysis of Return Loss for all three iteration of Complementary Slotted Octagonal Antenna.

Freq.	*S_{11}-3rd-Iter.*	*Freq.*	*S_{11}-2nd-Iter.*	*Freq.*	*S_{11}-1st-Iter.*
2.5	*-33*	*2.6*	*-30*	*2.7*	*-22.5*
3.6	*-19*	*3.7*	*-28.5*	*3.7*	*-17*
4.1	*-27*	*4.1*	*-22*	*4.2*	*-17*

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Table – 4
Comparative Table in between simulated and measured results for Third Iteration of Slotted Octagonal antenna

S.NO.	*Resonant Frequency(GHz)*	*Simulated (Return Loss In (dB)*	*Measured (Return Loss in (dB)*
1	*0*	*0*	*0*
2	*0.2*	*-2*	*-19.8*
3	*0.8*	*-5*	*-11*
4	*1.67*	*-7*	*-11*
5	*1.81*	*-8*	*-20.7*
6	*2.5*	*-24*	*-20*
7	*3.5*	*-17*	*-12.21*
8	*4.1*	*-26*	*-28*
9	*4.9*	*-36*	*-30*
10	*5.5*	*-19*	*-21.8*
11	*5.7*	*-16*	*-20.2*
12	*6.3*	*-17*	*-21.8*
13	*6.54*	*-10*	*-21.8*
14	*7.59*	*-8*	*-20.2*

One of the interesting obsevation from analysis of third iteration of this antenna obtained that this can also serve the Ka and Ku band as well Table 4 shows the comparision in between simulated and measured results shown in Figure

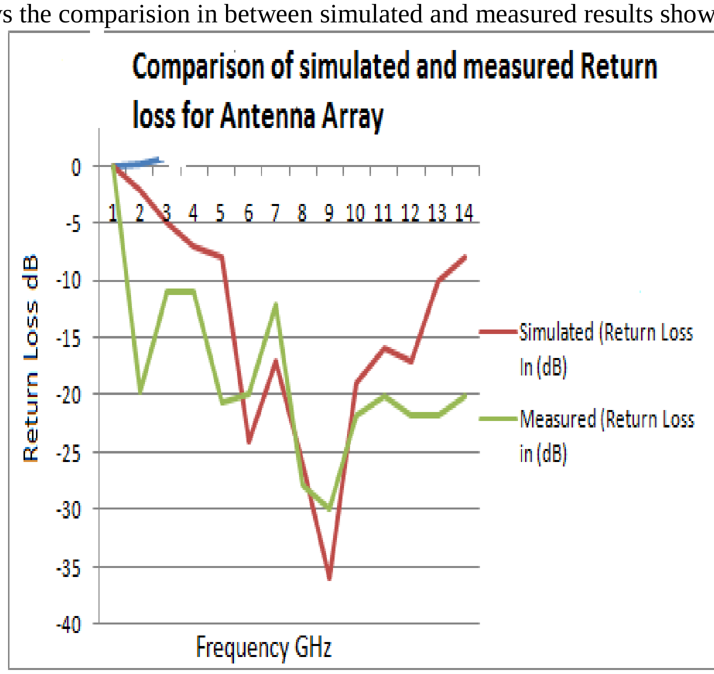

Fig. 7: Comparison Curve between Measured and Simulated Return Loss for Fabricated Slotted Octagonal Fractal Antenna

III. Future scope

This paper provided a consequential role on the multiband fractal micro divest patch antenna system for mobile communication in this era of wireless communications, still there are some other areas which has equipollent impedance that require attention. They include miniaturization of the antenna element without loss of efficiency, since the whole apparatus is getting more and more minimized in order to integrate within a minimum space thus requires further research work now a days. Minimizing electromagnetic energy absorption by the user's head can be one other paramount area for study, since there may be health hazards, if the users head is circumvented by a vigorous electromagnetic energy for a long time. One other area can be for research the effect of the ground plane dimensions on the performance of the antenna element in order to increment system performance.

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