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DESIGN AND ANALYSIS OF A FRACTAL SHAPED ANTENNA OVER A META MATERIAL

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Abstract - The main aim of our project is to construct antenna using fractal patterns in order to obtain desired performance properties. Here are some of the prevailing trends in the present day wireless devises and they are reduce in physical size and multi-band character. A reduction in physical size and multi-band capability are thus important design requirements for antennas in future wireless devices. The usage of fractal patterns in antenna design provides a simple and efficient method for obtaining the desired compactness. A proof-of-concept fractal antenna was designed with a thickness of 2mm by keeping meta material as a substrate. A compact, multi-band antenna based on the sirenpinski fractal was designed to operate at 0 to 10.0 GHz. Simulations were performed using the software packages i.e., ADS to calculate s-parameters like gain, directivity etc.,. The design methodology used, simulation and test results, as well as design recommendations are presented.

1. INTRODUCTION

In modern era, man is the alter ego of luxury. A device supporting WLAN, GPS, GPRS, Bluetooth and many more devises have been used in our day to day process. If an antenna is used for each and every devise separately, the size of the desired device will become infinity. Fractal antenna seemed to be the answer for this demand. Now the question arises what a fractal antenna is? Succinctly, an antenna with a self-similarity design to enhance the perimeter of material under the affect of electromagnetic radiations within a given total surface area or volume is called as fractal antenna.

2. FRACTAL THEORY

In conventional micro-strip patch antennas, multiband behavior was achieved by using multiple radiating elements or reactively loaded patch antennas and the same is possible with self-similarity property in case of fractal antennas. Basically, these antennas are self-loading as capacitance and inductance are added without use of any external components. As a result they consist of various number of resonant frequencies.

3. SIRENPINSKI FRACTAL ANTENNA

The sirenpinski fractal antenna is a good example of a self-similar antenna that shows multi-band behavior. It shows several resonance bands. The stages of construction of a fractal antenna are as show in the figure. Initially an equilateral triangle and in the next step the center triangle with vertices located at mid-points of the sides of the former triangle are removed. The triangular fractal is generated by continuous iteration in this process, an infinite number of times.

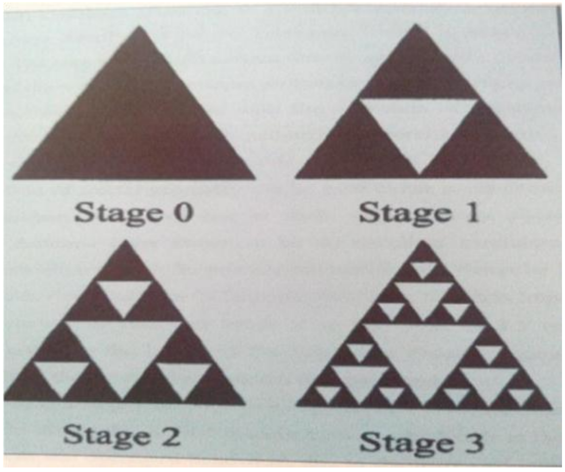

Fig 1 Iterated sirenpinski[1] patch antenna

The fractal antenna is designed on the metamaterial substrate a thickness of 2mm.

4 . Sirenpinski fractal antenna design by using ADS:

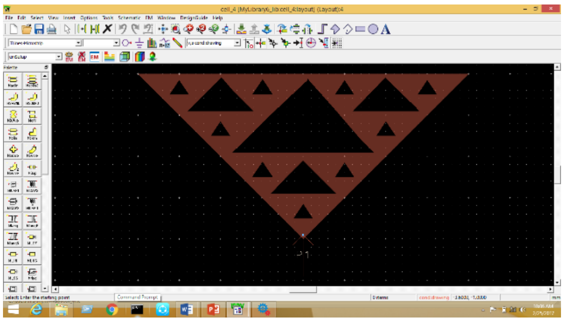

Fig 2: patch design in ads

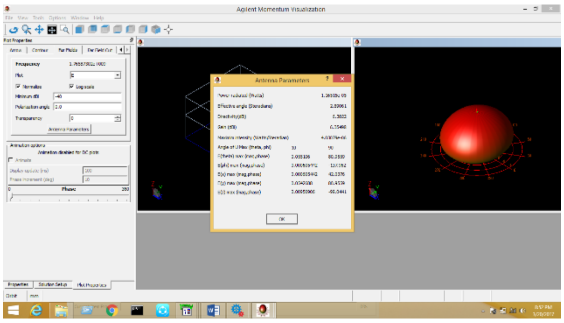

Fig 3: Checking out gain, directivity

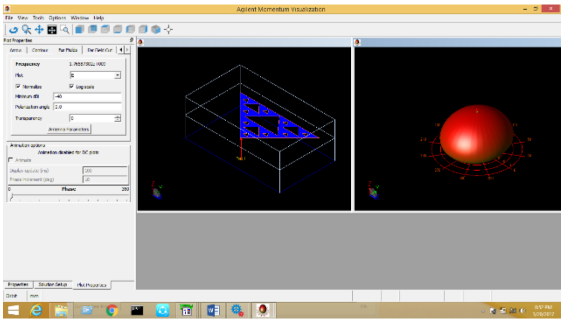

Fig 4: 3-d view of antenna

Iteration 1:

Sl.no	Parameter	Air 25mm	Fr-4 25mm	SRR 2mm
1	Frequency	1.667	1.667	1.765
2	Gain	- 26.071	5.212	6.354
3	Directivity	8.335	5.237	6.382
4	Efficiency	0.36	99.436	99.375

Table 1 Frequency from 1.6 to 1.7 GHz

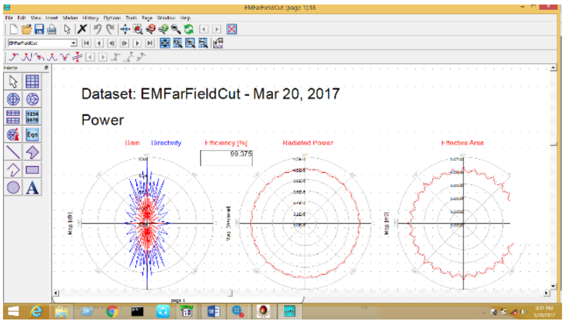

Fig 5: Efficiency of antenna with srr as substrate at 1.765 GHz in 1st iteration.

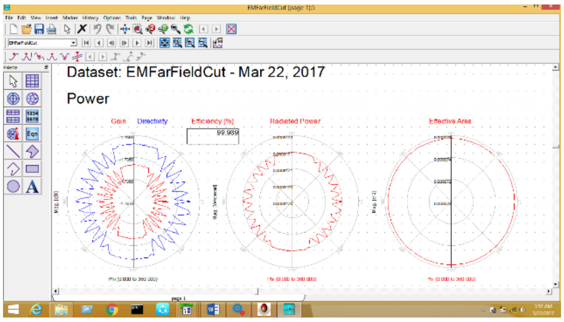

Fig 6: Efficiency of antenna using fr-4 as a substrate with 1.667 GHz

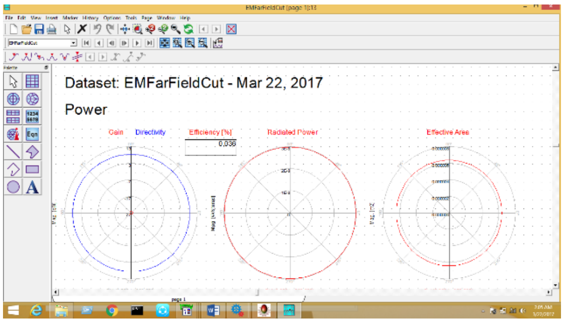

Fig 7: efficiency of antenna by using air at a frequency of 1.667 GHz

Iteration 2:

Slno	Parameter	Air 25mm	Fr-4 25mm	SRR 2mm
1	Frequency	6.667	5.462	5.119
2	Gain	-5.674	6.144	6.3038
3	Directivity	8.535	6.618	6.33
4	Efficiency	3.739	99.913	99.397

Table 2 frequency from 5 to 6 GHz

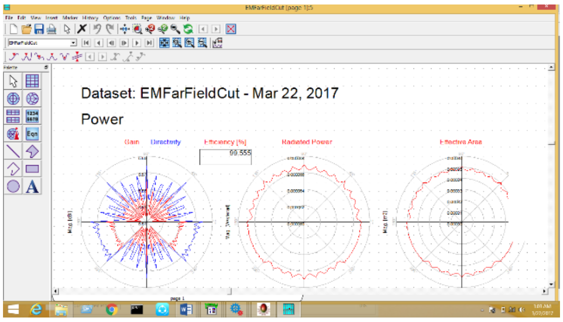

Fig 8: the efficiency of srr at 5.119 GHz in 2nd iteration.

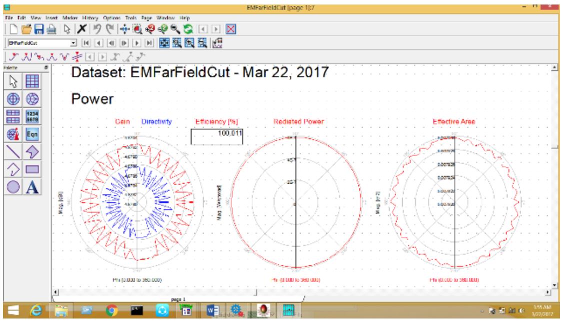

Fig 9: Efficiency of antenna using fr-4 at a frequency of 5.467 GHz in 2nd iteration

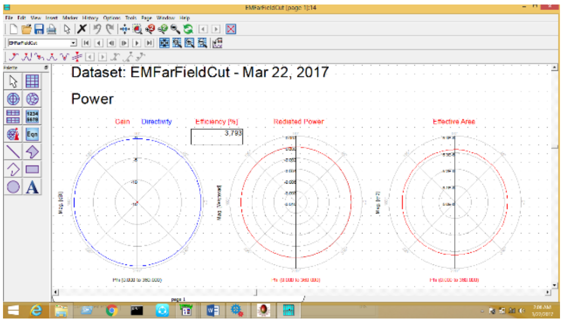

Fig 10: Efficiency of antenna by using air at a frequency of 6.667 GHz in 2nd iteration.

Iteration 3:

Sl.no	Parameter	Air 25mm	Fr-4 25mm	SRR 2mm
1	Frequency	8.333	7.962	8.571
2	Gain	-0.79	6.40	5.840
3	Directivity	8.172	6.42	5.86
4	Efficiency	12.675	99.449	99.55

Table 3: Antenna parameters in between the frequency of 7 GHz to 8 GHz.

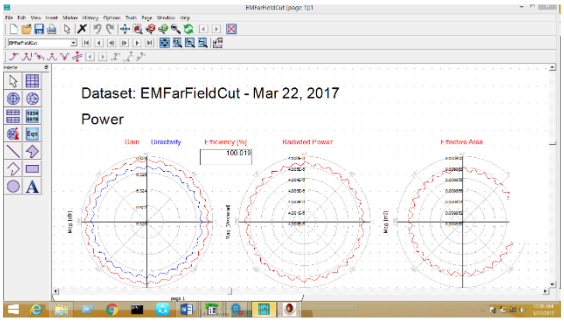

Fig 11: Efficiency of antenna using srr at a frequency 8.5 GHz in 3rd iteration.

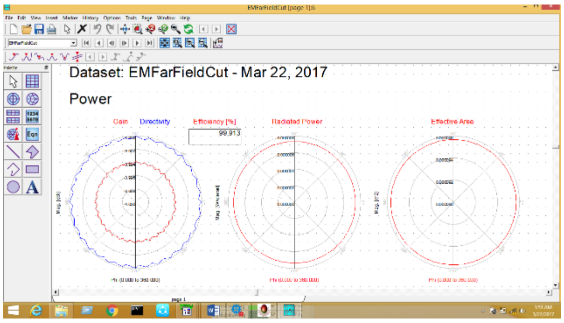

Fig 12: Efficiency of antenna using fr-4 at a frequency of 7.962 GHz in 3rd iteration.

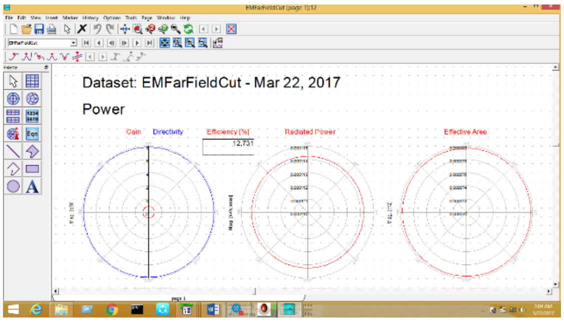

Fig 13: Efficiency of antenna using air at a frequency 8.33 GHz in 3rd iteration.

Return Loss of various substrate at different frequencies:

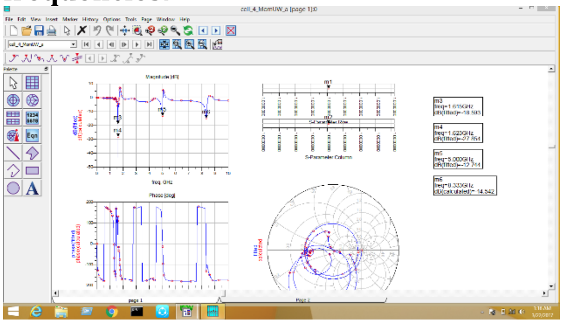

Fig 14: Return loss of anteena using srr

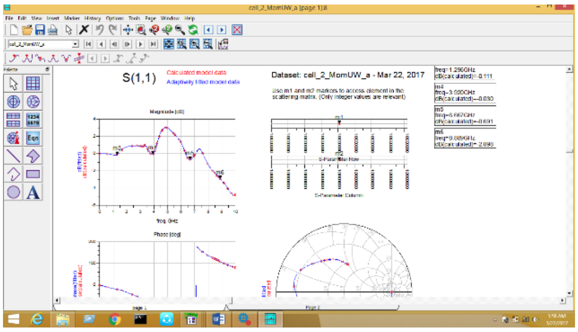

Fig 15: Return loss to antenna using fr-4

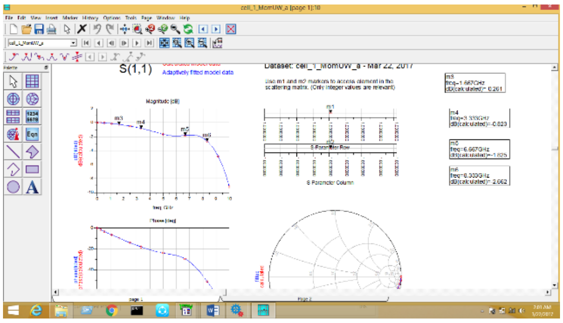

Fig 16: Return loss by using air as a substrate

CONCLUSION:

The unique feature of this fractal microstrip patch antenna is simple in its construction to get higher performance. In many applications basically in water antenna, it is necessary to design antennas with very high directive characteristics to meet the demand of long distance communication and the most common configuration to satisfy this demand is the fractal shaped microstrip antenna.

For an fractal shaped antenna with less thickness, the gain and directivity increased. However observing the performance analysis of the three mediums used in substrate we achieved the results. Hence by using SRR material as a substrate we shrieked the size of antenna from 25mm to 2mm and got the same results as we got for fr-4 material.

Here designed fractal antennas covers 10GHz operating frequency and it would also be possible to design the bands, operating any other system such as in WLAN, WIMAX, WBAN or other wireless systems, by changing the dimension of the patch element.

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