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A Compact Design And Analysies Of A Fractal Microstrip Antenna For Ultra Wideband Applications

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ABSTRACT : *In this paper a new ultrawideband fractal antenna is designed with the help of fractal geometries.The proposed design is an octagonal fractal microstrip patch antenna.With the advancement in communication technology over the past decade, there is an increasing demand for miniaturization, cost effective, multiband and wideband antennas. Fractal antennas can easily support these requirements. Also these antennas have unique properties such as self similarity and space filling.The simulation and optimization are performed using CST Microwave Studio simulator. The results show that the proposedmicrostrip fractal antenna can be used for 45 GHz –95 GHz frequency range, i.e., it is a super wideband microstrip antenna with 45 GHz bandwidth.The simulated results show that proposed antenna has very goodperformance in impedance bandwidth and radiation pattern.This antenna can be used in commercial telecommunication systems,satellite systems,radar systems and military telecommunication systems.*

KEYWORDS: *Bandwidth, fractal microstrip antenna, fractals, ultra-wideband .*

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I. INTRODUCTION

The development of reception apparatuses with fractal geometries has given a response to two of the principle confinements expressed by Werner (1999) of the established radio wires, which are the single band execution and the reliance in the middle of size and working recurrence [13].

Modern communication systems require antennas with more band-width and smaller dimension. One of the main components of ultraw-ideband (UWB) communication systems is an UWB antenna. Customarily, wideband antennas need different antenna elements for different frequency bands. If antenna size is less than a quarter of wavelength, antenna will not be efficient. 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]–[4].

Several UWB antenna configurations based on fractal geometries have been investigated including Koch, Sierpinski, Minkowski, Hilbert, Cantor, and fractal tree antennas in recent years.

In this Thesis, a fractal microstrip antenna is presented. This new fractal geometry is based on an iterative octagon. The huge band-width is the main advantage of this fractal antenna over conventional fractal antennas.

This antenna design is arranged in four sections. Design of proposed antenna is discussed in Section II. Simulated and measured results are presented in Section III and the conclusions are summarized in Section IV.

II. ANTENNA DESIGN

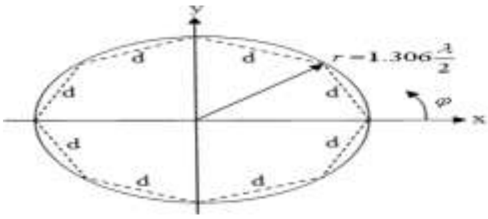


Figure-1: The geometry of octagonal circular subarray generator.

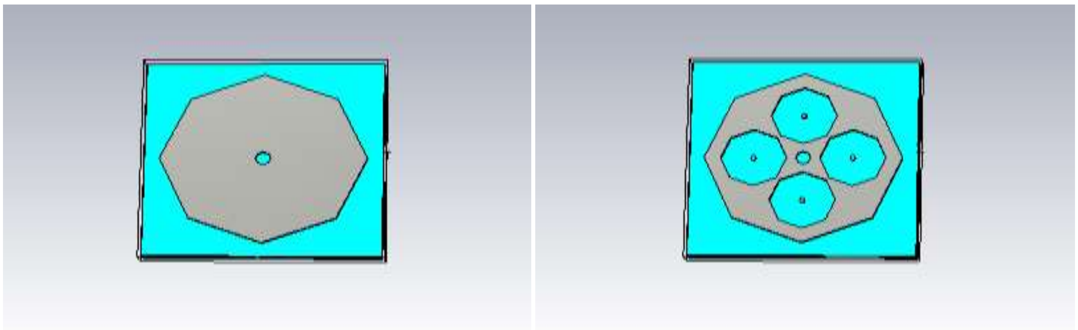
There are several types of fractal microstrip patch antennas. The most well-known fractal patch antenna is Sierpinski patch antenna such that the various types of it are used greatly in telecommunication systems. The quadrilateral and hexagonal fractal microstrip antennas were discussed in some papers.In initial process of this project, many designs and simulations are performed over fractal patch antennas. Thevarious types of quadrilateral, pentagonal and hexagonal fractal patch antennas are considered and finally the octagonal fractal shape is selected because of its good performances in bandwidth and gain. The standard octagonal arrays are formed by placing elements in an equilateral triangular grid. These arrays can also be viewed as consisting of a single element at the center, surrounded by several concentric eight element circular arrays. To investigate the designs for octagonal arrays via a recursive application, we consider the eight-element circular generating subarray of d shown in Fig 1. According to the octagonal properties, the interior angle is 135^o and the exterior angle is 45^o. Thus we can conclude

$$\frac{\frac{d}{2}}{r} = \cos\left(\frac{135}{2}\right)$$

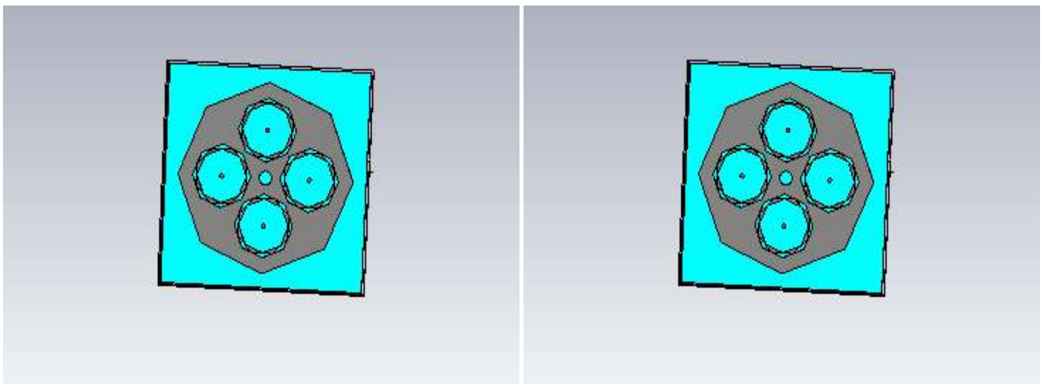
or, $r = 1.36 \times \left(d \text{ or } \frac{\lambda}{2} \right)$ ------------(1)

For this antenna, the length of each side of the octagon is d= 2 cm and the length of each side of the inner octagon is d/3. The proposed fractal geometry is placed on the Isola FR408 (loss free) substrate with relative permittivity ε=3.75 and thickness h=1.70mm. The dimension of the ground plane is chosen to be 6×6. The appropriate feeding location is in the maximum of electric filed.

The position of coaxial probe to match the input impedance Z=50Ω is founded exactly using simulation by this fact that the E-field must be maximum. Thus the location of the coax feed is placed on the patche which is 26.5mm from the center at the corner.



(a) 0^{th} iteration (b) 1^{st} iteration



(c) 2^{nd}iteration(d) final or 3^{rd} iteration

Figure-02: Different iterations of the proposed fractal antenna geometry

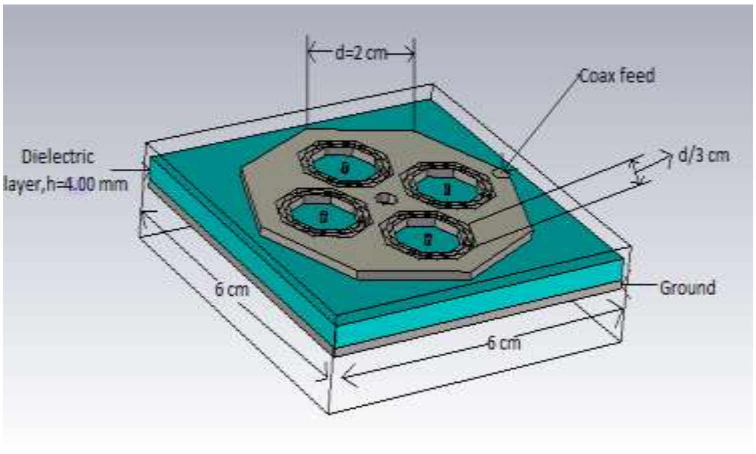


Figure-03: Complete structure of the proposed fractal antenna.

III. SIMULATION RESULTS

This microstrip antenna is simulated using commercial software CST Microwave Studio. The simulation frequency range is from 45 GHz –95 GHz. The measurement results are performed till 95 GHz. The simulated results of S_{11} parameters for different iterations, radiation patterns, VSWR, Current distribution and directivity for this antenna are represented.

A. Return Loss ($S_{11)}$:

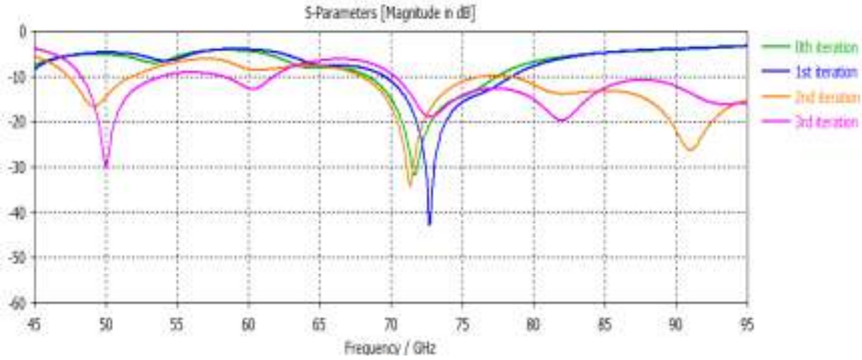


Figure-4(a): CST simulated return loss curves at different iterations

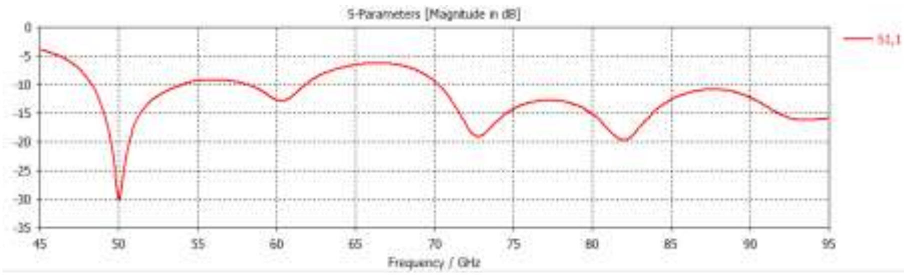
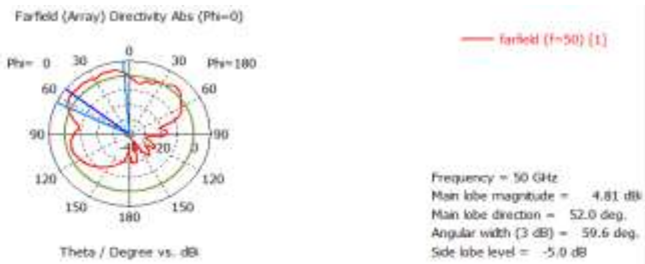
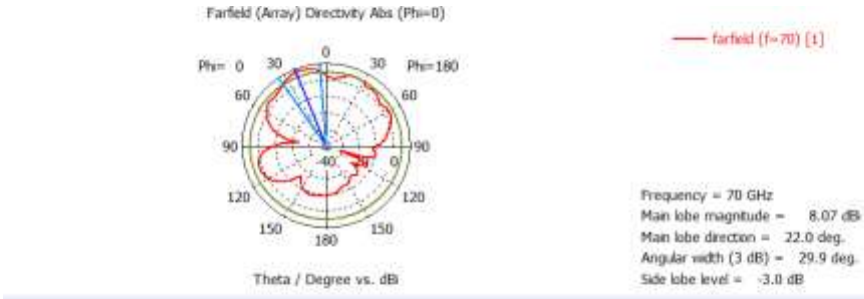


Figure-4(b): Return loss of the final iteration

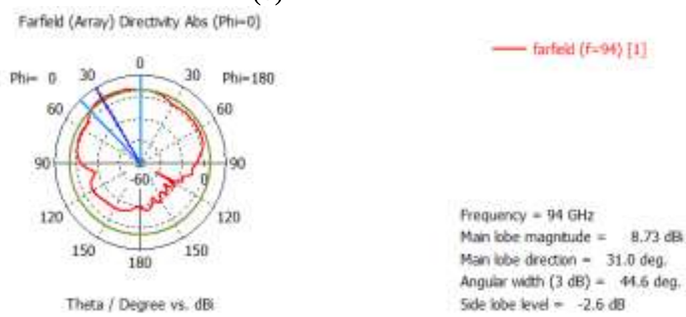
B. radiation patterns:



(a)



(b)



(C)

Figure-5: Radiation pattern of the proposed antenna at (a)50Ghz, (b)70 GHz (c) 94 GHz.

C. VSWR:

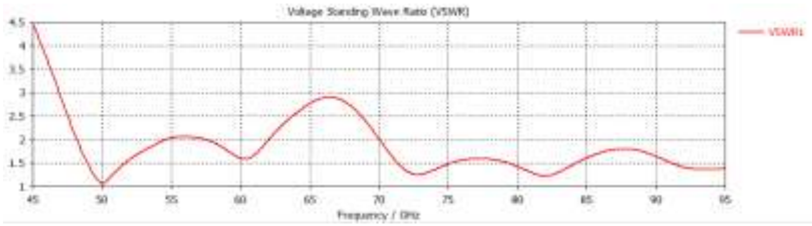


Figure-6: VSWR of the fractal patch antenna

D. Current distribution:

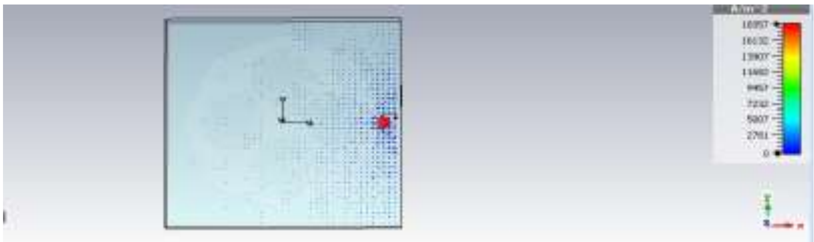


Figure-7: Current distribution for the fractal patch antenna.

E.directivity:

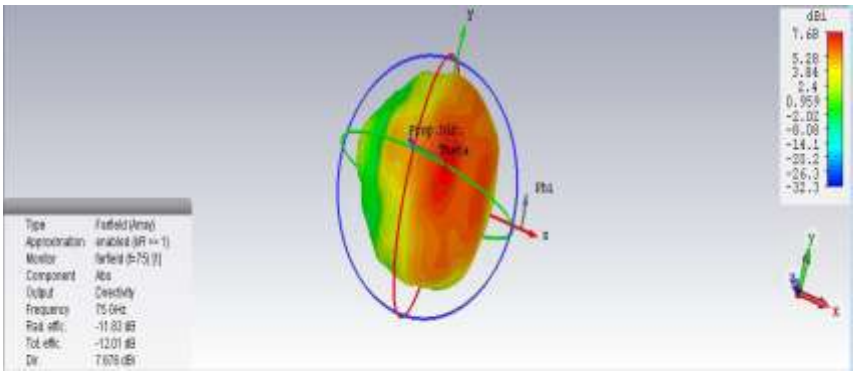


Figure-07: Directivity of the proposed fractal patch antenna.

IV. SUMMARY OF PARAMETERS

Table-1: Summary simulated result at 75 GHz frequency

Parameter	Value
Radiation efficiency	-11.83 dB
Total efficiency	-12.01 dB
Directivity	7.676dBi
Gain	3.15dB
Return Loss	-14.1638 dB.
VSWR	1.4815

V. CONCLUSION

An antenna serves as the “transition” between the RF front-end circuitry and the radiation and propagation of electromagnetic waves in free space. Antennas play a critical role in microwave and other wireless applications systems. Planar oriented antenna, such as microstrip patch has attracted significant attention among antenna engineers due to the tremendous benefits they bring to modern wireless systems in comparison to more conventional designs. In satellite, radar and military communication systems require light weight, compact, and low cost antennas with possibility of conformal integration. As we know, the fractal microstrip patch antenna is a good choice to be used in these systems. In this thesis we have designed a fractal microstrip patch antenna using CST 2017.

From the results of simulation we can see that the proposed fractal antenna is capable of operating at 50 GHz, 60.24 GHz, 72.72 GHz, 82.93 GHz and 94.45 GHz frequency and would be suitable for wideband wireless application.

For further understanding the behaviour of the proposed antennas, Surface current Distribution and 2D Radiation patterns are presented. The Simulated results have confirmed the wideband behaviour of the proposed antennas with a nearly omnidirectional radiation properties over the entire frequency band of interest. These features make this attractive for future communication systems.

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