ISSN 2395-1621

T Shaped Fractal Geomerty Based Micro Strip Patch Antenna

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ABSTRACT

Since the evolution of the patch antennas, there is rapid growth observed in the applications of the patch antenna. There are number of advantages such as small size, ease of fabrication and installment, and a stable performance, so there are huge number of designs has been developed and presented by the researchers time to time. Taking an example of the mobile phone antennas, the antenna must have a small size and must be capable to resonate at multiple frequency bands. Reviewing about the various requirements of the antenna design for the wireless applications a novel multiple band fractal patch antenna has been designed. In this paper, a T-shaped patch antenna has been designed and discussed and fractal geometry has been applied to it in order to obtain self-similar characteristics. The dimensions of the Square Patch has been taken as 36 x 36 mm. Dimension of ground has been taken as been taken as 50 x 50 mm. The substrate material used for antenna design is FR-4 having dielectric constant 4.4. Antenna resonates at four operating bands 3.89 GHz, 4.49 GHz,and 6.1 GHz . This antenna has return loss of -12.10 dB, -9.74dB, and -21.08 dB . Further this antenna has impressive gain of 6.4 dBi, 3.42 dBi and 2.48dBi at corresponding frequencies. This antenna can be useful for Wi-Max, 4G network, WLAN, Satellite & RADAR communication applications.

Keywords : Wireless applications, WLAN, Fractal Micro strip Patch Antenna

ARTICLE INFO

Article History

Received :16th March 2016

Received in revised form : 18th March 2016

Accepted : 20th March 2016

Published online : 23rd March 2016

I. INTRODUCTION

Antenna is one of the largest components of the low profile wireless communication. In order to transmit and receive antenna information, modulation is done in which career wave is superimposed over modulating signal. At the required destination, the modulated signal was then received and the original information signal can be recovered by demodulation. Over the years, techniques have been developed for this process using electromagnetic carrier waves operating at radio frequencies as well as microwave frequencies. In the current scenario small, compatible and affordable microstrip patch antennas are developed in wireless communication industries keep on improving antenna performance. A patch antenna is a narrowband antenna with large beam width. It is fabricated by etching the antenna element pattern in metal trace which is bonded to an insulating dielectric substrate such as a printed circuit board with a continuous metal layer bonded to the opposite side of the substrate known as a ground plane. Fractal geometry is used to reduce the size of patch antenna. Fractal geometries are different from Euclidean geometries which have two common properties: space-filling and self-similarity. It is found that by applying fractal geometry, self-repeating structures are obtained. Fractal geometries that are used in this dissertation are Koch curve, Minkowski fractal geometry and many other self-similar shapes. By applying fractal geometry on patch, area of patch decreases, resonant length increases and number of frequency bands of antenna increases. Microstrip antenna finds applications from 1 GHz to 12 GHz. Hence microstrip antenna can be designed for L band, S band, C band and X band applications.

II. LITERATURE SURVEY

a) Nagpal et al. proposed E-shaped fractal microstrip patch antenna with defected ground structure for wireless applications. Different iterations of fractal geometry caused self-similar E shape structures. For obtaining good bandwidth, Different DGS configurations had been applied. This antenna was designed using FR-4 as substrate and operated at 3.7GHz, 6.7 GHz, 7.9 GHz and 8.7 GHz with bandwidth of 120 MHz, 500 MHz, 225 MHz and 315 MHz. This antenna found its application for Wi-Max, C Band and X band applications. This antenna is having small dimensions of 20X25 mm2. Results have been compared first making E-shaped patch which modified to form wang shape followed by fractal antenna.

b) Khidre et al. presented U slot microstrip antenna for higher mode applications. This antenna resonated in a band from 5.17 GHz to 5.81 GHz hence useful for number of applications. This antenna was having dual radiation beams with both beams were directed at centre frequency. This antenna was having a gain of 7.92 dBi. This antenna found its applications for different wireless applications. This antenna exhibit impedance bandwidth of 11 % at VSWR less than two. This antenna was having dimensions of 64X 74 mm2. Substrate was having a dielectric constant of 2.2 and thickness of 3.1 mm. Design and simulation had been carried out using HFSS.

c) Gupta et al. designed multiple band microstrip patch antenna. This antenna had been useful for c band and x band applications. This microstrip antenna was having a patch with different slots so as to have good antenna characteristics. These slots were four U slots, two small and two large and one I shaped slots. This antenna was having compact size of 25 X 23 mm2. Feed to this antenna is given by coaxial feeding technique and feed point is chosen properly. Design and simulation had been carried out using HFSS simulation software. This antenna was having bandwidth of 140 MHz from 5.85 GHz to 6 GHz and 1.21 GHz from 7.87 to 9 GHz. This antenna can be used for WLAN, C band and X band applications.

d) Janani.A et al. designed E-shaped fractal patch antenna for multiband applications. For obtaining multiple bands, fractal geometry had been used. First of all, entire length was divided to form E shape patch by cutting two slots. On each section, fractal geometry was applied so as to make fractal antenna. . The proposed antenna had dimensions of 150 mm by 130 mm using two FR-4 having thickness of h=0.8 mm and h= 1.6 mm and an air gap having thickness h= 4 mm between two FR-4 as substrate. The design and simulation had been carried out using HFSS simulation software. The main parameters at operating bands such as return loss, impedance, gain had been studied. This antenna found its application for different applications for mobile communication.

e) Waladi et al. designed fractal microstrip patch antenna using star triangular shape. Fractal geometry had been applied on triangle to obtain star shape antenna. This antenna was fed by microstrip feeding technique which was having width of 4.8 mm and length of 1.9mm. This antenna was having large bandwidth of 30 GHz from one to 30 GHz at VSWR less than two. This antenna had been used for ultra wideband and short wideband applications. This antenna had wideband characteristics because of presence of notch with dimensions of 4.8 X1.9 mm2.

f) Ghorpade et al. made a comparison between E-shape antenna and E-shaped fractal microstrip patch antenna. From this analysis it was found that fractal antenna gave multiband characteristics. This antenna had large size of order of 150X130 mm2. The design and simulation has been carried out using a software HFSS. Characteristics of antenna were compared in terms of VSWR, return loss, gain and bandwidth. Because of fractal geometry, E-shaped fractal antenna resonated at 1.93 GHz, 2.4 GHz, and 3.52 GHz to cover GSM frequency bands, UMTS, Bluetooth and Wi-Max applications. By increasing number of iterations beyond limit, results began to degrade.

G)Kumar Raj et al. proposed an ultra-wideband inscribed triangle circular fractal antenna. This antenna had a circular patch with dimensions of 30 mm. In order to design such antenna, substrate used was FR-4. This antenna had ultra wideband characteristics from 2.25 GHz to 15 GHz at VSWR less than two. The antenna was fed by coplanar waveguide. By applying fractal geometry CPW, wideband characteristics were obtained. The results of simulated antenna were compared with that of tested antenna and both offered same characteristics. Because of such a large bandwidth, these antennas were useful for UWB applications.

IV. PROPOSED SYSTEM

The term fractal is defined as recursively generated object. Fractal geometry can be available easily in nature but by using recursive nature of fractals, many antennas and resonators can be designed. A fractal is a chunk geometric shape that may be subdivided in parts; each is a reduced size copy of the whole. By increasing number of fractal iteration, perimeter of patch increases and effective area of antenna decreases. The fractal is quite extensive with many applications from nature modeling, statistical analyses, and computer graphics. Fractal geometries are different from Euclidean geometries which have two common properties: space-filling and self-similarity. When different iterations of fractal geometries are applied on antenna or resonators, as the result self-similar structures with scale factor are obtained. Certain fractal may be constructed using iterative procedure of fractal geometry using Iterative Function System (IFS) Procedure. IFS procedure is applied to an initial structure called as generator which repeats itself many times at different scales. Fractal antennas have the advantages such as small size, lightweight, and suitable to integrate with devices.

ANTENNA DESIGN

Design of Fractal Micro strip Patch Antenna:

Design of T-shaped fractal micro strip patch antenna has been obtained by applying fractal geometry.

Variable	Value
Dimension of square patch	36mm
Dimension of square ground	50mm
Substrate used	FR-4
Feeding Technique	Coaxial Feed
Fractal geometry algorithm	Minkowski Geometry
Dimension of first iteration	12*18
Dimension of second iteration	4*9

Table-1: Dimensions of antenna.

First of all, square of 36 mm is divided into half, and 36 mm is divided into 3 parts. Hence two a rectangle of 18 mm in length and 12 mm in width are removed to form T-shaped patch as shown in Figure 2.

Fig-1: Basic Square Geometry

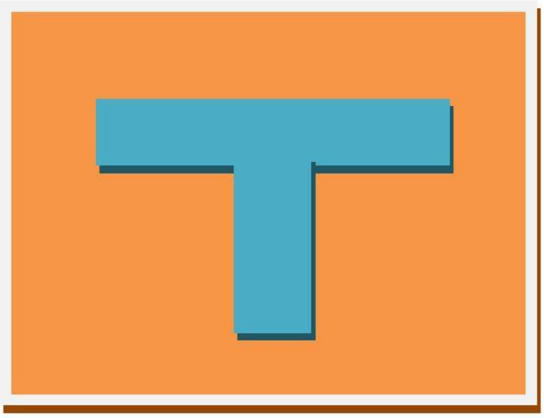

Fig-2: First Iteration

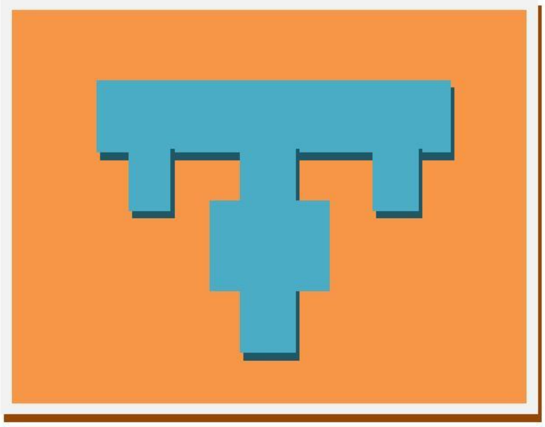

Fig- 3: Second Iteration

Now four rectangles of dimension 12 X 18 mm are formed hence x axis is divided into three parts and y into two and two rectangles of dimension 4 by 9 mm are removed from rectangle to form self similar structure as shown in Figure 3. Geometry as shown in Figure 1, 2, and 3 is self similar structures geometry. Beyond a certain level of iteration, it is difficult to fabricate antenna as cuts become small which cause difficult for antenna to make practically.

V. RESULTS & DISCUSSION

T-Shaped Fractal Patch Antenna: In this section, simulation results of different iterations of fractal geometry are compared. T shape fractal antenna is made by cutting slots as shown in Figure 1, 2, and 3. These cause self-similar T-shaped structure. Return loss vs. frequency for various iteration of T-shaped fractal geometry are shown in Figure 4 , 5 , 6

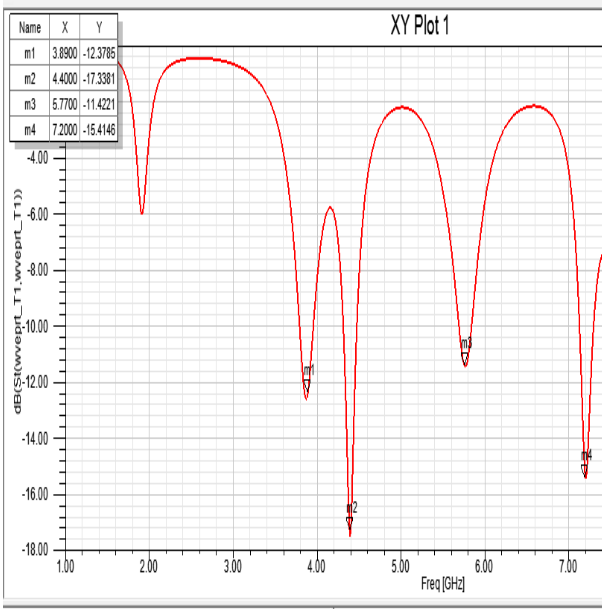

Figure 4 : Return loss of 0^{th} iteration

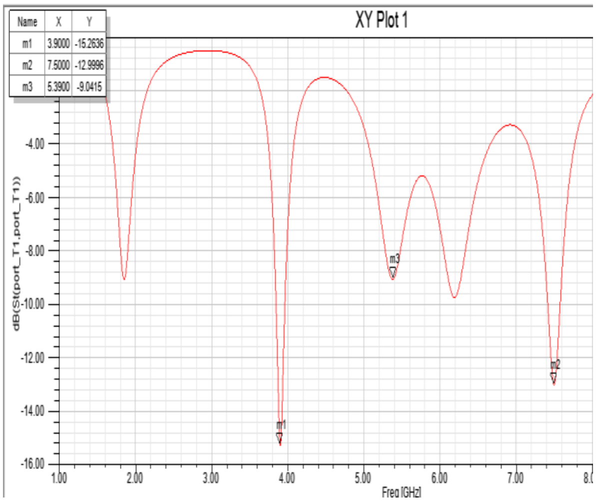

Figure 5: Return loss of 1st iteration

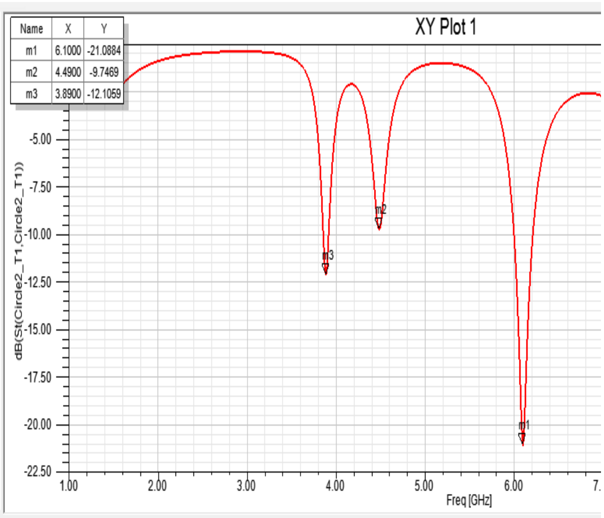

Figure 6: Return loss of 2nd iteration

From Figure 4, 5, 6 it is found that characteristics of antenna increases as number of iterations increases, initially square antenna resonates at 3.89 GHz, 4.4 GHz and 5.7 GHz and 7.2 with return loss of -12.3 dB, -17.3 dB, -11.42 dB and -15.4 dB. since characteristics of antenna at zeroth iteration are not good so fractal geometry has been applied to improve characteristics. Two slots are cut as shown in Figure 2. This antenna resonates at 3.9 GHz, 5.4 GHz and 7.5GHz with return loss of -15.2dB,-9dB, and -12.9 dB respectively. As results obtained are good but resonant frequency bands are having more return loss hence second iteration of fractal geometry is applied. When second iteration of fractal geometry is applied as shown in figure 3, antenna resonates at 3.9 GHz, 4.5 GHz,and 6.1 GHz with return loss of -12.1 dB, -9.7 dB and -21 dB respectively. When first iteration of fractal geometry has been applied, effective length of patch increases which result better antenna characteristics.

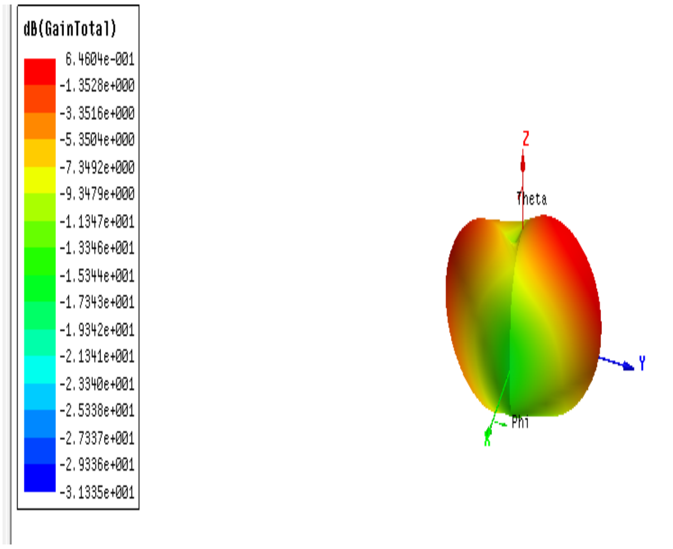

Figure 7: Gain of T- shaped FMPA at 3.9 GHz

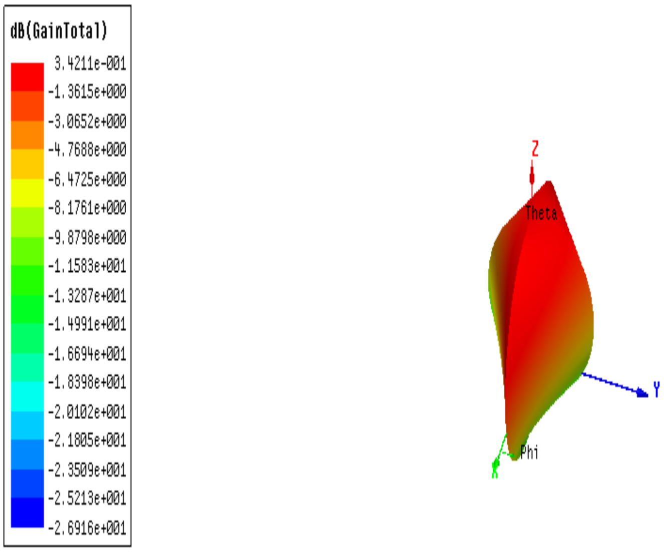

Figure 8: Gain of T- shaped FMPA at 4.49 GH

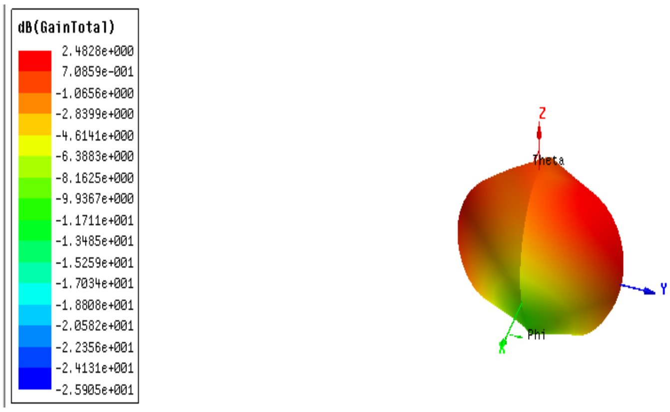

Figure 9: Gain of T- shaped FMPA at 6.1 GHz

No.of iteration	Resonant Frequency (GHz)	Return Loss (dB)	Gain (dBi)
0^{th} iteration	3.9	-12.3	3
	4.4	-17.3	1.2
	5.7	-11.42	4.4
	7.2	-15.4	5.7
1^{st} iteration	3.9	-15.2	1.09
	5.4	-9	2.36
	7.5	-12.9	6.69
2^{nd} iteration	3.9	-12.1	6.46
	4.5	-9.7	3.42
	6.1	-21	2.48

Table - 2: Comparison Results of Different Iterations of T shaped FMPA.

V. CONCLUSION

Multiband T-shaped fractal antenna is obtained by applying fractal geometry .Initially a rectangular patch is taken and fractal geometry is applied. Two iterations of fractal geometry are applied to form T-shaped fractal antenna. This antenna gives multiband characteristics. There are different configurations of changing feed points, changing dielectric substrate which can be applied. In order to analyze characteristics, antenna configurations are observed by using different feeding configurations, it is also observed that one of best comparison is made by using microstrip line and comparing result by use of coaxial feed Design and simulations are carried out using HFSS. From results it is found that parametric analysis had been carried out in terms of substrate thickness, feed point and number of iterations.

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