Modified E-Shaped Fractal Design using Proximity Coupled Non Contacting Feeding Technique for S & X Bands Applications

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Abstract: ***In this era of technology and advancement, wireless communication plays a very important role for transfer of information may it be audio or video. And antenna forms a basic component of wireless communication. This research paper focuses on comparison between coaxial feeding technique, & proximity coupled feeding technique. E-shaped fractal antenna is obtained by applying Minkowski fractal geometry algorithm. It has been observed that purposed antenna having approximately 10 times greater bandwidth as compare to conventional antenna.***

Keywords: Microstrip patch antenna, Feeding Techniques.

1. Introduction

At present, in wireless communication there is need of compact and fast communication so multiband antennas are required. As small antennas are capable of resonating at multiple bands so these are in great demand. Microstrip antenna finds various applications in the aircraft and missile applications where important requirements are its size, its weight and complexity. Although they are less bulky and capable of resonating at different bands but they suffers from many disadvantages like its small bandwidth, low gain, poor polarization, high Q factor and low efficiency. There are number of techniques for improving characteristics of microstrip patch antenna which includes the use of fractal geometry and their defected ground structure (DGS) and also its cutting slots on patch. Fractal means broken or irregular fragments. There are number of fractal shapes like Minkowski, Hilbert curve, Koch curve, Sierpinski and fractal arrays. By applying fractal geometry on patch, area of patch decreases and resonant length increases and number of frequency bands of antenna also increases. Since it is also important to have wideband characteristics, so defected ground structure plays an important role in improving bandwidth of an antenna.

MICROSTRIP PATCH ANTENNA

Microstrip patch antenna was introduced in 1950s but became popular and took place in various applications in 1970s by Howell and Munson, since then a massive amount of research and development effort have put into it. It consists metallic portion on one side of dielectric and metallic portion on other side of substrate. Patch is made up of copper/gold because of their good conductivities. It radiates because of fringing field between patch and ground of antenna. This phenomenon has been accelerated due to its advantages over antennas structures. This seems almost like the perfect antenna, but there is one main drawback, the bandwidth which typically is from a fraction of a percent to a few percent depending on the substrate dielectric constant and thickness.

2. Literature Review

R. Choudhary etal.[4] "A Dual Band Compact Circularly Polarized Asymmetrical Fractal Antenna for Bluetooth and Wireless Applications". In this paper, a dual band Compact fractal antenna is proposed for circular polarization (CP). The proposed antenna was designed to operate at dual bands having bandwidth 1 GHz and 8 GHz at resonant frequencies 2.4 GHz and 12.9 GHz respectively for Bluetooth and wireless applications with good return loss and radiation pattern characteristics. It consist asymmetrical antenna by truncating the sides of a square patch. The proposed antenna was fed by a 50- micro strip line and fabricated on a low-cost Rogers-RT5880 substrate having dimensions 50(L) × 50(W) × 3.2(h) mm3 with ∈r= 2.2 and tanɵ= 0.0009. The antenna shows acceptable gain with Omni-directional radiation patterns in the proposed frequency range.

S. Yadav etal.[1] "A Dual Band Star Fractal Antenna with Slot for Wireless Applications". In this paper, a Dual Band Star fractal antenna with slot was proposed for wireless applications, with a semi-elliptical ground plane. The proposed antenna was designed to operate at two different bands having bandwidth I GHz and 1.2 GHz at resonant frequencies 2.8 GHz and 5.7 GHz respectively for wireless applications with good return loss and radiation pattern characteristics, in the frequency band.

U. Soni etal. [2] "Koch Curve Fractal Antenna for Wi-MAX and CBand Wireless Applications". In this paper, Koch curve fractal antenna is proposed for wireless applications. The antenna had been designed by increasing the perimeters of triangular shape patch by using self similarity property. Number of iterations by the designing Koch snowflake for different resonant frequency, were given.

Pushpanjali J. etal.[3] "Full Composite Fractal Antenna with Dual Band used for Wireless Applications" In this paper a full composite fractal antenna, having a modified Sierpinski fractal antenna with 50Ω micro strip line, used for dual band wireless applications.

A.Rajshree etal.[5] "a modified sierpinski gasket triangular multiband fractal antenna for cognitive radio". This piece of writing describes about a modified Sierpinski gasket fractal multiband antenna for cognitive radio applications. This proposed new micro strip modified triangular fractal antenna having multiband behaviour in five different resonant frequencies 11.58GHz, 14.15GHz, 20GHz, 30GHz and 35GHz respectively that covers the frequency bands such as X band(8-12GHz), Kuband(12-18GHz), K band(18 - 26.5GHz),Kaband(26.5-40GHz). This antenna had certain advantages like compact (30×30mm) , high directivity(8.15 - 11.86 dBi) and gain(3.2-8.6dBi).And also the analysis was carried out for five different resonant frequencies to synthesize the antenna parameters such as radiation pattern, gain and directivity. The output results prove that this one was well suitable for spectrum sensing in cognitive radio.

B.Taoufik, etal.[6] "Fractal Multiband Planar Antenna for Wireless Power Transmission". In this paper we have developed and designed a low cost fractal Multi band micro strip antenna structure. This antenna was validated in the ISM (Industrial Scientific and Medical) band at 2.45 GHz and 5.8 GHz. The aim of this work is to develop an antenna which can be associated with an RF-DC rectifier to design a rectenna system for wireless power transmission "WPT". The technique used to have a multiband structure is the fractal geometry. The final circuit was a fractal multiband antenna with 65 x 30 mm2 as dimensions.

Ghatak et al. [7] had covered in their paper a second iteration Sierpinski carpet fractal shape UWB antenna with hexagonal boundary. 3 GHz to 12 GHz (VSWR $\leq$ 2) frequency band is covered by this antenna. This antenna had the capability to reject 5.15–5.825 GHz band assigned for IEEE802.11a and HIPERLAN/2 which is attained by inserting a 'Y' shaped slot in the radiator that extends to the central conductor of the CPW feed as well. The simulation and experimental results are very close for the fabricated prototype. Within the band the measured peak antenna gain ranges from 1.25 dBi to 6 dBi . This antenna had a compact size of 33 mm × 32 mm in which we have a substrate around the radiating element. From the time domain characteristic it is revealed that the antenna is non-dispersive having a variation of measured group delay within 0.5 ns over the entire band.

Research Objectives

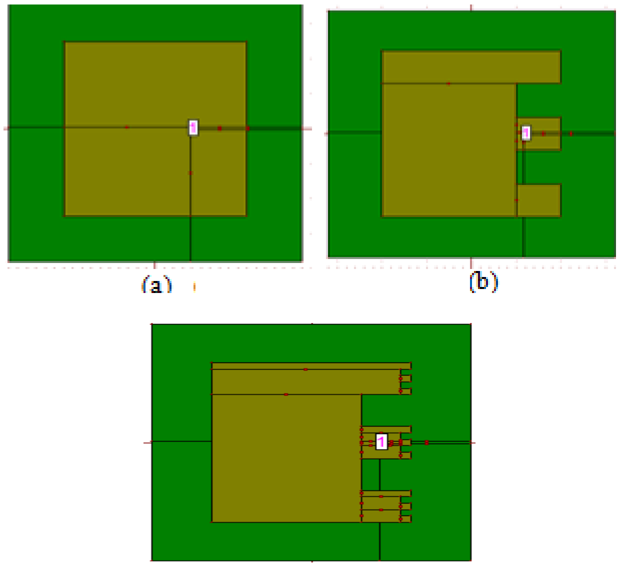
Objectives of the research paper are being proposed as:

- Design of the Rectangular E shaped fractal microstrip patch antenna**.**
- Simulation of Rectangular E shaped fractal microstrip patch antenna**.**
- Optimization of antenna parameters for larger bandwidth, gain and low return loss.

3. Simulation and Result Analysis

E-Shaped FMPA Design

Antenna corresponding to zeroth iteration is shown in Figure 1(a). First iteration of fractal geometry is applied by cutting two small squares of dimensions 5 mm from square of 20 X 25 mm^2. Feed to antenna is given at point for obtaining better results. Here scale factor is chose to be one fifth. That is entire length is divided into 5 equal parts to make E-shaped antenna. Geometry corresponding to it is shown in Figure 1 (b). To make E-shaped fractal microstrip patch antenna, one has to also apply next iteration of fractal geometry. For it small cuts are made of dimensions 1 mm are removed from square of dimensions 5mm. Geometry corresponding to it is shown in Figure 1(c). From Figure 1 (a), (b) and (c), it is found that self-repeating structures are obtained.



(c)

Figure 1: E- Shaped FMPA **(a)** 0th Iteration, **(b)** 1st Iteration and **(c)**2nd Iteration

Feed to antenna is used as coaxial feeding technique we can also use microstrip line feeding technique.

Effect of Changing Feeding Technique

In this research, E-shaped fractal patch antenna has been designed using different feeding techniques:

i). Coaxial feeding technique.

ii). Proximity coupled feeding technique.

Figure 2(a) shows the E-shaped fractal patch antenna that is feed by coaxial feeding. In figure 2(b), proximity coupled feed has been applied on E-shaped fractal patch antenna.

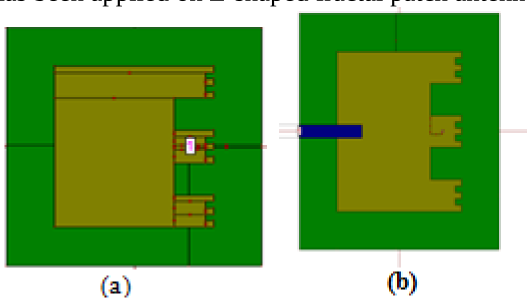


Figure 2: E-shaped fractals patch antenna using (a). Coaxial feeding, , & (b). Proximity coupled feeding.

Proximity coupled feed

In this it has been applied two substrates i.e. substrate 1(lower) & substrate 2(upper). In lower substrate, the dielectric value has greater than the value of upper substrate. In lower substrate FR4 dielectric material has been used. In upper substrate Rogers Dielectric material has been used. In both of substrates, microstrip line has been used. Microstrip line is between the two substrates so E-shaped fractal patch antenna is physically not connected with the micrpstrip line. This is the basic concept of the proximity coupled feeding technique.

E-shaped Fractal Patch Antenna E-shaped structure as shown in Figure 1 is obtained by applying two iterations on Fractal geometry on rectangular patch having rectangular slot. First two slots are cut so that E-Shape structure is formed. Return loss versus frequency for different iterations are shown in Figure 3. Comparison between two feeding techniques shown in table 1.

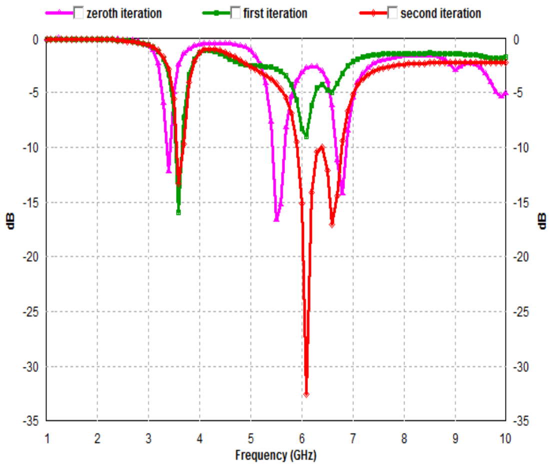


Figure 3: Return Loss Vs. Frequency for Different Fractal Iterationsof E-shaped FMPA

Table 1: Characteristics of Antenna with Different Feeding Techniques.

Feeding Technique used	Resonant Frequency (GHz)	Return Loss (dB)	Gain (dBi)	Bandwidth (MHz)
Using coaxial feed	3.6	-13	3.8	150
	6.1	-33	2.1	850
Using Proximity feed	3.6	-18	3.88	1360
	11.2	-23.6	6.28	1400

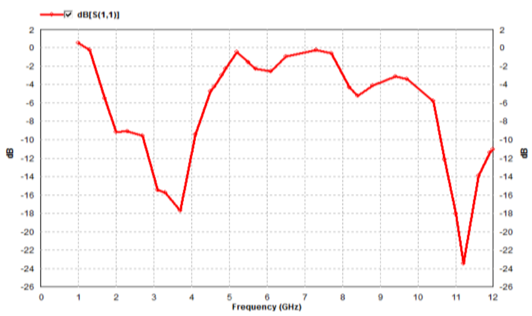


Figure 4: Return loss vs Frequency of Proximity feed

4. Conclusion

Multiband E-shaped fractal antenna is obtained by applying fractal geometry. One of best comparison is made by using comparing results of coaxial feed Design and Proximity coupled feed Design and simulations are carried out using IE3D. E-shaped fractal antenna is obtained by applying Minkowski fractal geometry algorithm. E-shaped fractal patch antenna by applying Proximity coupled technique; antenna resonated at two bands namely 3.6 GHz and 11.2 GHz with return loss of -18 dB and -23.6 dB, gain of 3.88 dBi and 6.28 dBi, directivity of 6.20 dBi and 9.74 dBi. This antenna has bandwidth of 1360 MHz and 1400 MHz at frequency of 3.6 GHz and 11.2 GHz. This antenna has been found best applications for WLAN, Bluetooth, cellular phones, Wi-Fi, Long distance radio telecommunications, Satellite, & Microwave relay and for different S and X bands applications.

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