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NOVEL INSET FEED MINIATURIZED FRACTAL PATCH ANTENNA FOR WI-FI APPLICATIONS

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ABSTRACT

Fractals are profoundly intricate shapes that are easy to design. These contours are able to add more electrical length in less volume. In this paper, a new approach in designing multi band micro strip patch antenna for Wi-Fi application is introduced. The presented approach is based on applying fractal geometry to a square loop antenna. The proposed antenna has the advantage of low profile, light weight and easy fabrication and is potential for wireless communication modelling and simulation is performed via IE3D and ADS electromagnetic simulator.

KEYWORDS: Fractals - Fractal Antennas - Wi-Fi – Micro Strip Patch, Antenna –Wideband

INTRODUCTION

Recent years have seen increased the use of wireless data system with the expansion of WLAN/Wi-Fi services. Cost benefits, high data rates, standardization, interoperability and strong worldwide support by industry are resulting in broad deployment of this technology across enterprises, homes, and service providers. The mobility of WLAN systems is also of increasing interest. The popular application of WLAN in mobile phones, laptops and Personal Digital Assistants (PDAs) has made mobile WLAN systems a research topic. These services require antennas with more bandwidth and smaller dimensions compared to conventional antennas. Fractal geometry is a very good solution to fabricate these antennas. This cause wide spread researches on fractal antennas recently. In this paper, a miniaturized square fractal micro strip antenna provided with loaded slots and inserting square loop antenna with inset feed at the centre and choosing appropriate size and location for feeding fractal antenna is designed for antenna miniaturization.

BACKGROUND ANALYSIS

In this paper, we provide a comprehensive overview of recent developments in the rapidly growing field of fractal antenna engineering. This article presented a comprehensive overview of the research area we call fractal antenna engineering. Included among the topics considered are (1) Design methodologies for fractal antenna elements, (2) Application of fractals to the design of antenna arrays, and (3) Frequency-selective surfaces with fractal screen elements. The field of fractal antenna engineering is still in the relatively early stages of development, with the anticipation of much more innovative advancement to come over the months and years ahead [1]. Presents an over view of how antenna array technology can be used to improve digital cellular systems. It describe the potential improvement in coverage and system capacity, and discuss trade-offs involved for each system. It is also described the wireless system impairments (multi path fading, delay spread, co-channel interference) and how antenna array techniques to overcome these impairments. This explains how range, capacity and data rate are increased by using this system [2]. Paper [3] has been achieved to a 40GHz super wideband antenna with applying fractal geometry to a wire square loop antenna and choosing appropriate size and location for feeding. Modeling and simulation is performed via SuperNEC electromagnetic simulator. Results of simulation show that suggested antenna is multi-band and broad-band, because it is operational in 20 – 60GHz frequency range. The proposed design is a loaded 3rd iteration of tee fractal antenna and selects an appropriate location for feeding. Also, the proposed structure has a small dimension of 3.5×3.5 cm². Due to the simulation results, can be conclude that it is a super wideband antenna with 40GHz bandwidth and significant gain in entire bandwidth. New fractal geometry for microstrip antennas is presented in this paper. This fractal structure is implemented on hexagonal and several iterations are applied on initial shape. This antenna has low profile, lightweight and is easy to be fabricated and has successfully demonstrated multiband and broadband characteristics. The simulated results show that proposed antenna has very good performance in impedance bandwidth and radiation pattern [4].

A small but long wire fractal antenna based on the Koch curve is presented. Experimental and numerical results show that the antenna improves the features of a common linear monopole. The radiation resistance is increased and the Q factor (Q) is reduced at each fractal iteration, approaching the fundamental limit on small antennas [5]. Fractals are space-filling geometries that can be used as antennas to effectively fit long electrical lengths into small areas. This concept has been applied to wire and patch antennas. Through characterizing the fractal geometries and the performance of the antennas, it can be surmised that increasing the fractal dimension of the antenna leads to a higher degree of miniaturization. Also, it has been shown that a high degree of complexity in the structure of the antenna is not required for miniaturization. Truncating the fine structure of the fractal that is not discernable at the wavelengths of interest does not affect the performance of the antenna. Therefore, miniaturized antennas can be fabricated using only a few generating iterations of the generating procedure. Two applications of these miniaturized elements were demonstrated for phased arrays with enhanced wide-scanning-angle radiation characteristics [6]. This article will describe the theories and techniques for shrinking the size of an antenna through the use of fractals. Fractal antennas can obtain radiation pattern and input impedance similar to a longer antenna, yet take less area due to the many contours of the shape.

Fractal antennas are a fairly new research area and are likely to have a promising future in many applications. Many variations of fractal geometries have been incorporated into the design of antennas [7]. This paper relates for the first time, multiple resonant frequencies of fractal element antennas using Koch curves to their fractal dimension. Dipole and monopole antennas based fractal Koch curves studied so far have generally been limited to certain standard configurations of the geometry. It is possible to generalize the geometry by changing its indentation angle, to vary its fractal similarity dimension. This variation results in self-similar geometry which can be generated by a recursive algorithm. Such a variation is found to have a direct influence on the input characteristics of dipole antennas [8]. A new coplanar waveguide (CPW) fed wideband printed slot antenna is presented and the impedance characteristics of this antenna with different sizes of tapers are discussed. The effect of tapering angle with the resonant frequency is also observed.

The fundamental parameters of the antenna such as bandwidth, return loss, gain, radiation pattern and polarization are obtained. All meets the acceptable antenna standards. The measured input impedance bandwidth (return loss < -10 dB) of the prototype antenna is 52% (4.27–7.58 GHz). The radiation patterns are bidirectional in both planes. This antenna can be part of various wireless communication systems [9]. The author gives a perspective over the basics of microstrip, rectangular, square patch antennas and the equations for determining L, W, and y_0 values [10].

FRACTAL GEOMETRY

Fractals are highly convoluted and jagged shapes in which these discontinuities increase bandwidth and effective radiation of antennas. Fractal antennas can place long electrical length into small volume using their ability of space-filling. Several wire antenna configurations based on fractal geometries have been investigated including Koch, Minkowski, Hilbert and fractal trees antenna in recent years. These antennas have been simulated using the moment method as well as fabricated and measured. In this paper another shape of fractal is presented. The dimension of fractal geometry is 3.5x3.5mm, operating frequency is 3GHz.

DESIGN OF BASIC SQUARE MICROSTRIP RADIATING ELEMENT

Design of an antenna is based on the wavelength λ and it's given by equation below. Basically, when the size of an antenna increases, the resonant frequency decreases. The basic square patch antenna is considered as a moderately based loading resonator then the resonant frequency can be given by the following equation

$$(f_r)_{mn} = \frac{c}{2l\sqrt{\in_r}}\sqrt{m^2+n^2}$$

where

$(f_r)_{mn}$ is mn mode resonant frequency in Hz,

l is length of the square patch antenna in m

The square microstrip patch element is designed to operate at 2.4GHz with following parameters:

Microstrip element width W=30mm

Effective dielectric constant ε_{reff}=4.4

Microstrip element length L=30mm

Feed line impedance Z_0=50Ω

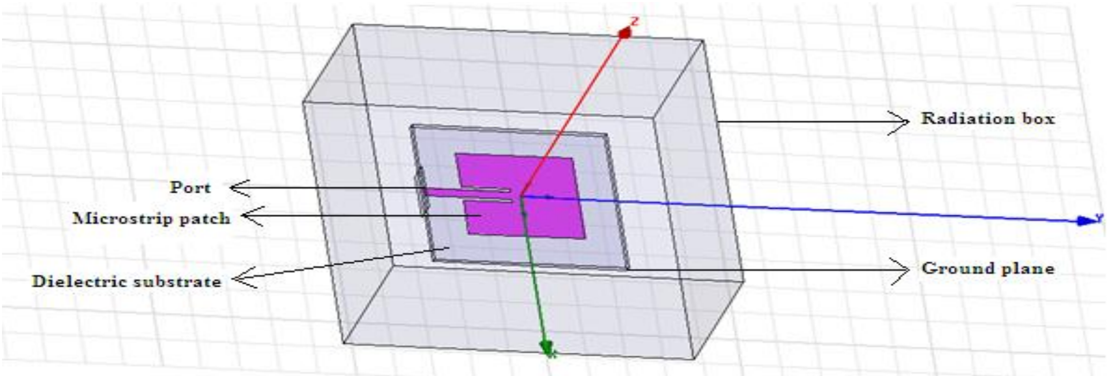


Figure 1: Geometry of Square Microstrip Radiating Element

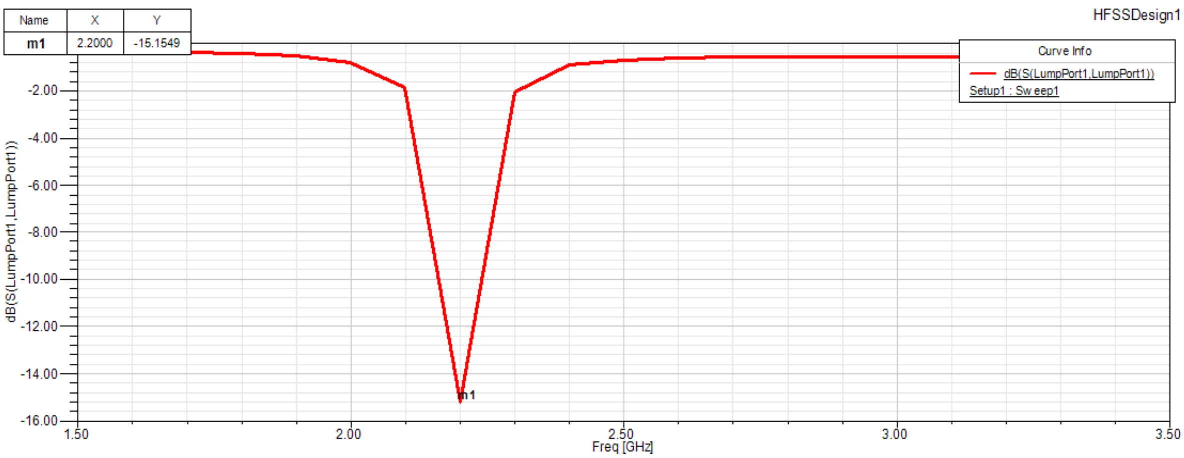


Figure 2: Return Loss vs Frequency Graph of Square Microstrip Radiating Element

ANTENNA SPECIFICATION

This fractal antenna is an iterative model to a normal square loop with a generator of the shape shown in figure 1. W (indentation width scaling) usually changes between 0 and 1, and here I have supposed W=0.5 that means the length of indentation is equal to half of the straight sections.

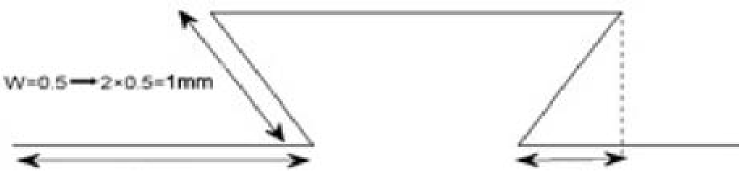


Figure 3: Proposed Generator

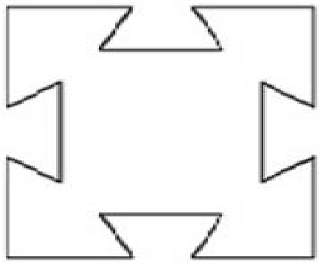
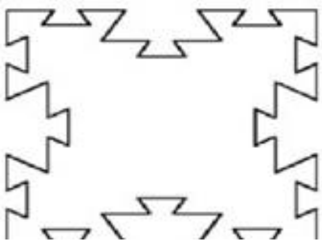


Figure 3a: Square Patch **Figure 3b: Iteration 1**



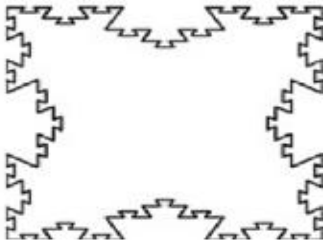


Figure 3c: Iteration 2 **Figure 3d: Iteration 3**

Results show that the location of feeding has many effects on antenna parameters and with changing it; I can change antenna parameters such as bandwidth and gain. Thus for maximum bandwidth I place feeding position according to figure 4.

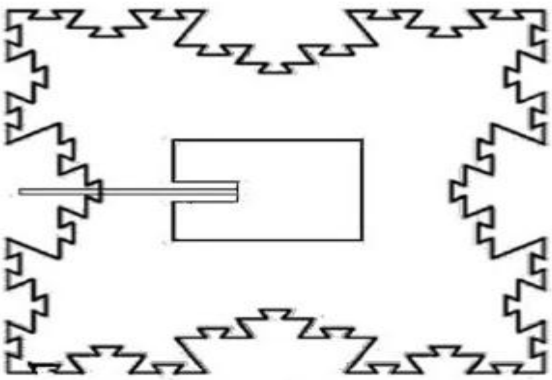


Figure 4: Antenna Structure

Here feeding is given to a square patch at the centre and feeding position to get the maximum impedance match. The dimension of Square patch is 1.5 x1.5 m

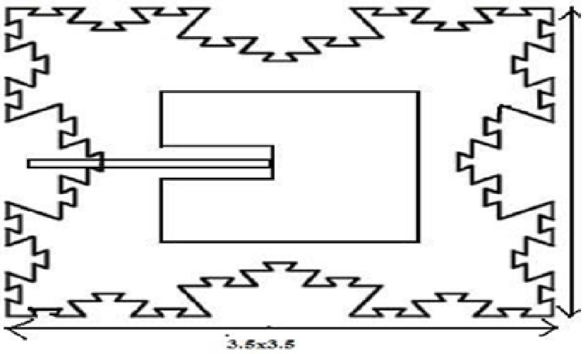


Figure 5 : Antenna Structure with Square Patch having Dinension of 2.5 x2.5

In figure 4 the dimension of square patch is 1.5x1.5 mm. Figure 5 Antenna structure with square patch has dimension 2.5x2.5 In figure5 the antenna structure has dimension 3.5x3.5 with a square patch has dimension 2.5x2.5 .by increasing the width of the square ,return loss also changes, herby adjusting the spacing we get the good return loss and impedance matching. Simulation results are discussed on next section.

SIMULATION RESULTS

The MOM (method of moment) is used for simulating this antenna with ADS electromagnetic simulator software. First I define the fractal geometry for software, and then I specify the location of feeding. Voltage source is 1 volt and frequency range is from 19GHz to 60GHz. Figures 6 and 7 depict the S11 (return loss) and VSWR (voltage standing wave ratio)..

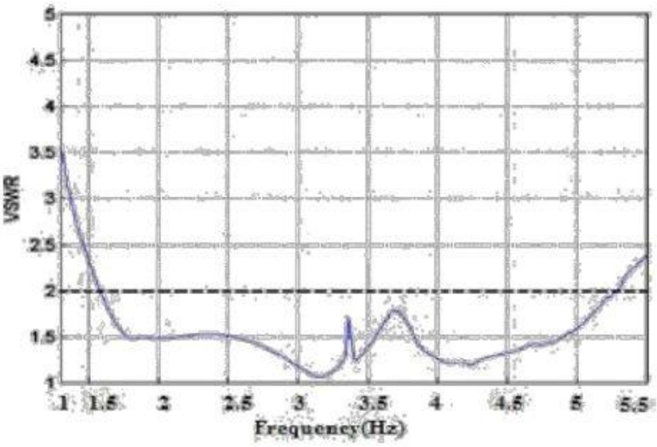


Figure 6: VSWR (Voltage Standing Wave Ratio)

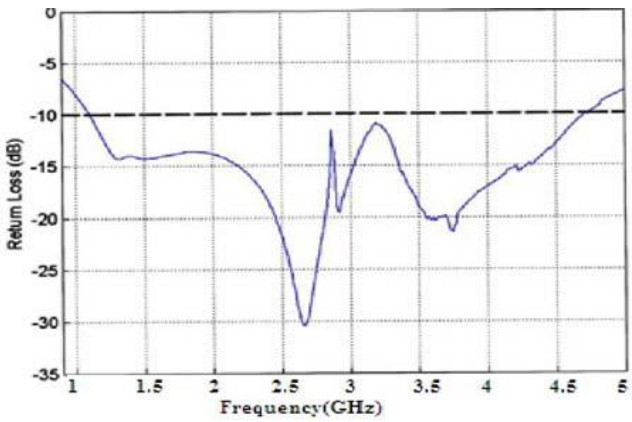


Figure 7: S11 Return Loss

RADIATION PATTERN

For the above designed antenna the below Figure8 and 9 depicts the radiation pattern at 2.4GHz, because in this frequency it attains maximum gain

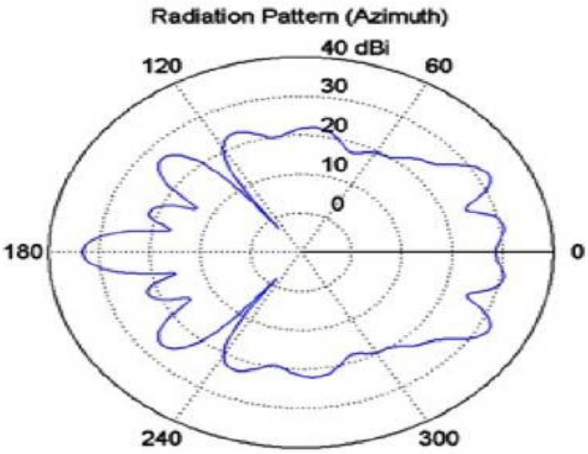


Figure 8: Radiation Pattern (XZ plane) at2.4 GHz

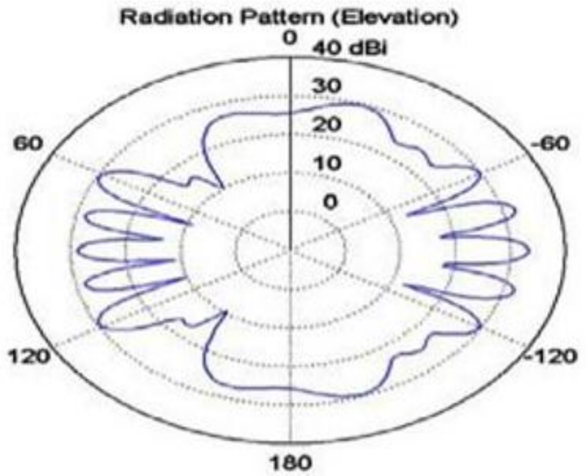


Figure 9: Radiation Pattern (YZ plane) at 2.4GHz

CONCLUSIONS

An improved fractal method is introduced to reduce the size of microstrip antenna .The novel inset feed microstrip patch antenna is constructed by cutting narrow slot that have length width ratio less than 5 on each side of the square patch and inserting a square patch at the centre for feeding. A comparison was taken between the new fractal antenna and the traditional Koch ones, and proved that the former increases the electrical length of the patch and reduces the physical size. The 3x3mm antenna resonates at 2.4GHz, and reduces the area of square patch by 62%.

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