Research Paper Engineering

Design And Analysis of Various Parameter of Patch Antenna Using Fractal Geometries

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ABSTRACT

- In the field of low profile antenna, Microstrip Antennas have attracted many researchers due to smaller size and low cost of fabrications. One of the recent outcomes and trending member of new designs is Fractal Antenna. A fractal is an object achieved by recursive arrangements of a shape or pattern, keeping it same at every scale. In this project, a comprehensive overview of recent developments in the field of fractal antenna engineering will be done in the first phase. Various fractal shapes and their properties will be discussed and compared. Modifications in original designs will be done to achieve targeted response by applying iteration techniques. Techniques for frequency-independent multi-band and broadband characteristics will be studied and designed using schemes for realizing loss-free designs, size reduction and thinning. The designs, simulations, fabrications and measurements will be done using Ansoft HFSS

KEYWORDS Microstrip patch antenna, Fractal antenna, Sierpinski carpet.

INTRODUCTION

Increasing users and expansion of research has made field of mobile communication extremely attractive to researchers these days. One of the ways to provide suitable answer of increasing demands of this field is to create antennas with wider bandwidths, higher gains antennas have gone far from their basic definition of "a metallic device for radiating or receiving radio waves".

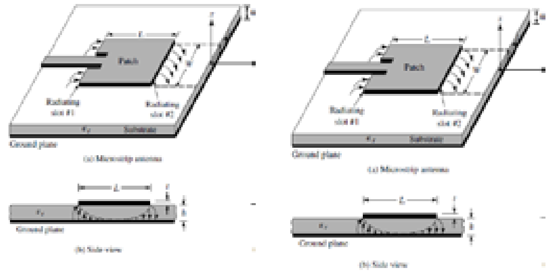

Figure1.Operation of Fringing Field in Patch Antenna

Many authors used the attempt to adjust the boundaries of the frequency bands using a modication of known fractal . A fractal is a natural phenomenon or a mathematical set that exhibits a repeating pattern that displays at every scale. If the replication is exactly the. same at every scale, it is called a self-similar pattern.

Antennas or arrays with fractal geometry possess four desirable attributes which are compact size, low profile, conformal and multiband or broadband, which may benefit from inherent self-similarity in their geometrical structure. It attracts a number of researchers to the fractal engineering where a variety of excellent results have been obtained.

In the paper, based on techniques of fractal shape and corner cutting, we propose an innovative design for broadband antenna. Micro-strips patch antennas with several advantages such as conformal nature, light weight, and easy integration. Since compact antennas can achieve the same performance as large antennas do in a low price and ease with integration technology, reduction of antenna parameter is becoming an important design parameter. Several methods have been suggested to reduce the size of micro-strip patch antenna.

FRACTAL ANTENNA CONCEPT

Fractal antennas have become a hot topic of interest for the antenna designers because of their unique features like compact size, multiband operation etc. Many articles are found in open literature on fractal antennas. The application of fractal geometry to conventional antenna structures optimizes the shape of the antennas in order to increase their electrical length, which thus reduces their overall size.

Though different fractal geometries are available, a very few can be used in the design of Microstrip antennas. One such geometry is Sierpinski Carpet. The size of edge fed microstrip patch antenna can be reduced for the same resonant frequency without affecting the performances, such as the return loss and radiation pattern by etching the rectangular microstrip patch as Sierpinski carpet of different iteration orders.

A fractal is an object achieved by recursive arrangements of a shape or pattern, keeping it same at every scale. Hence, they are called as self-similar patterns. This phenomenon is useful to create many objects, including antennas. Due to its recursive nature, we can easily increase length or perimeter of the radiating element without adding volume to it.

Due to this self-similarity, fractal antennas can provide high gain multiband and wideband solutions. These antennas are low profile, easy to be fabricated, light weight and exhibit advantageous properties over other antennas of similar applications. In addition, it allows us to design miniature antennas and integrate multiple telecommunication services such as cellular, wireless LAN ,Wi-Fi and GPS into a single device due to multi band characteristics.

DESIGN

The Sierpinski Carpet

The Sierpinski carpet is a simpler design compared to many other fractals. In its basic concept, it is made on a square or a rectangle by making 9 equal parts of it. From the nine such parts, the one in the centre is removed. Thus made design is repeated with a one third scale at the rest of the eight parts.

The exercise can be repeated to numbers of levels. Fig. 2 shows the Sierpinski carpet up to three levels.

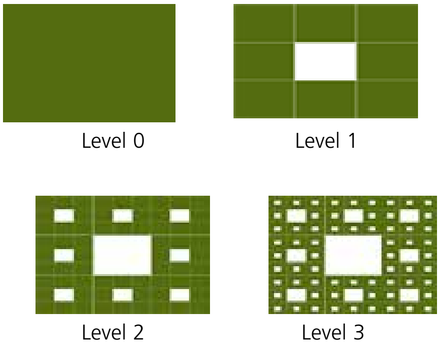

Figure 2. Modeling of Sierpinski carpet up to level3

Antenna Design

The dielectric material of the substrate selected for this design is FR-4 which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna. The resonant frequency selected for my design is 2.4 GHz.

Height of dielectric substrate (h): For the Micro-strip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is 1.56mm .

1) Calculation of the width W of antenna

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r+1}{2}}}$$

Where, f0 = resonant frequency,

r = Dielectric constant of the substrate

2) Calculation of Effective dielectric constant

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1 + 12\frac{h}{w}\right]^{\frac{-1}{2}}$$

3) Calculation of Length Extension (LD)

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)(W/h+0.264)}{(\varepsilon_{reff}-0.258)(W/h+0.8)}$$

4) Calculation of Actual Length (L)

$$L = L_{eff} - 2\Delta L$$

5) Calculation of Actual Wavelength in medium

$$\lambda = \frac{\lambda_0}{\sqrt{\varepsilon_{reff}}}$$

The Iso View And Top view Of All Level

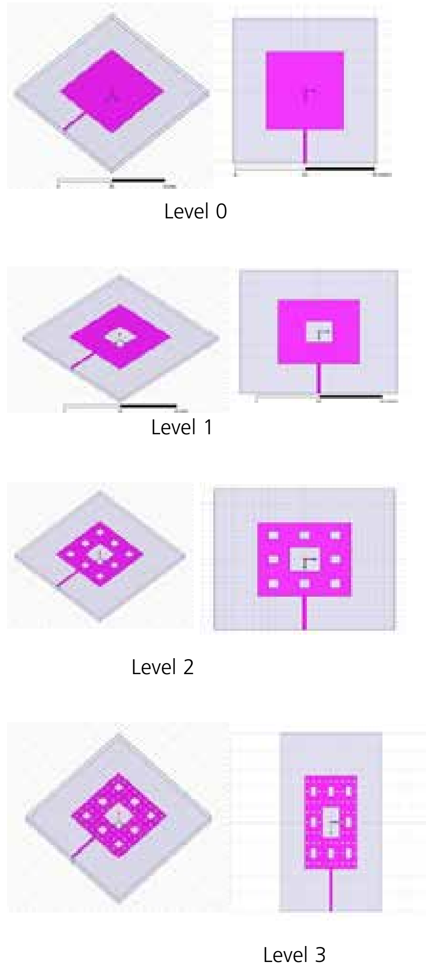

Fig.3Antenna models of each level of Sierpinski Carpet.

Software Simulator

There are a number of commonly available software packages which allow the simulation of antenna parameters. Some of the best known are: IE3D, HFSS, SONNET, CST. The software will use to model and simulate the Propose Micro-strip patch antenna is Ansoft HFSS.

HFSS is a commercial finite element method solver for electromagnetic structures from Ansys. It originally stood for "High Frequency Structural Simulator ". It is one of several commercial tools used for antenna design, and the design of complex RF electronic circuit elements including filters, transmission lines, and packaging.

ANSYS HFSS software is the industry-standard simulation tool for 3-D full-wave electromagnetic field simulation and is essential for the design of high-frequency and high-speed component design.

RESULTS

Return loss and Radiation Pattern results are extracted for ensuring antenna performance on practical grounds. Fig. 4 shows the Return Loss plot for level 0.

Fig. 4 Return Loss For Level 0

The Return Loss plot clearly shows the resonance frequency of 2.45 GHz at marker m2. Hence, antenna is tuned at 2.45GHZ. The value of Return Loss at 2.45 frequency -16.0231 dB which ensures full transmission of input signal. It also ensures that the feed location is optimized and the impedance is matched.

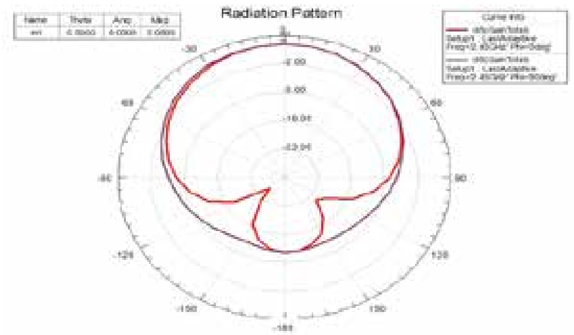

Fig. 5 Radiation Pattern For Level 0 at Phi = 0 and Phi = 90

TABLE I : Results and Miniaturization at Each Level

Fractal Level	Results		
	Return Loss (dB)	Total Gain (dB)	Miniaturization (%)
Level-0	-16.0231	3.0895	26
Level-1	-10.7246	2.2651	19
Level-2	-10.6910	2.1427	14
Level-3	-11.3588	2.1799	14

CONCLUSIONS

In this paper, the Sierpinski carpet edge fed Microstrip patch fractal antenna is proposed for size reduction. The antenna is designed and iterated up to third iteration . The proposed antenna is designed for the resonant frequency of 2.45GHz. The proposed antenna show a significant size reduction compared to the conventional Microstrip patch antenna. The size reduction of 16% is achieved at third iteration without affecting other performances such as return loss and radiation pattern .

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