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Design And Simulation of Sierpinski Pre fractal Antenna Using HFSS

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***Abstract*—A compact triangular patch Prefractal Sierpinski antenna with micro strip feed line for multiband and moderate gain antenna for portable communications systems respond to the great demand for both commercial communications systems and military is designed with HFSS Ansoft v11 and fabricated on TEFLON. The results demonstrate that the proposed antenna with triangular slots at special positions can generate steady radiation pattern and is capable of wrapping the frequencies demanded by UWB Communication system, RFID, Wi-Fi, GSM, WiMax. Good agreement between the simulated and measured results further validates the utility of presented antenna for proposed application.**

For operational frequency of 2.25 GHz, 4.15 GHz and 6.25 GHz, VSWR bandwidth nearly 2.4 and return loss bandwidth up to -15.85db has been obtained. A triangular slots and cut plays an important role in balancing resistive part and reactive part which affects the impedance matching. A thick dielectric substrate is helpful in increasing the bandwidth.

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I. INTRODUCTION

Antenna is the one of most important elements of the wireless communications systems. Thus, the field of antenna design has become one of the most attractive fields in the communication studies and research. The micro strip patch antenna is one of the recently developed types of antenna. Communication has an important role to play in the worldwide society now days as the communication systems are rapidly changing over from "wired to wireless" [1]. Wireless technology provides low charge alternatives and a flexible way use for communication. A Micro strip patch antenna be a type of antenna that offers a low profile i.e. thin and easy manufacture facility, which offers a great advantage over usual antennas [2]. Patch antennas are planar antenna use in microwave applications and other wireless links. The Micro strip technique is a commonly used planar technique that produces defenses conveying signals and antennas combination such radiated waves and lines. It uses conductive strips or patches formed on the top surface of a thin dielectric substrate separating them from a conductive layer lying on the bottom surface of the substrate and constitute a ground for the line if not the antenna.A patch is typically wider than a strip and its figure and dimension are important features of the antenna. Micro strip antenna is most suitable part to be used as active antenna. Active antenna is an antenna which have all necessary components such as an antenna element, a feeding circuit, active integrally provided lying on a monolithic substrate, thus producing compact, low charge, multi-function antenna equipment[1]. Micro strip patch antennas are almost certainly the most generally used type of antennas today due to their advantages such as light weight, low volume, low cost, compatibility with integrated circuits and easy to install on the strict surface. Furthermore, they can be simply designed to operate in dual-band, multi-band application, dual or circular polarization. They are important in countless commercial applications. However, micro strip patch antennas naturally have narrow bandwidth and enhancement is usually a demand for practical applications, so for extending the bandwidth countless approaches have been utilized. In addition some applications of the micro strip antenna in communication system requires smaller antenna size in organize to meet the devices or active circuits [2].

II. FRACTAL ANTENNA

Benoit Mandelbrot, who lead the way of classifying this geometry, first coined the name 'fractal' in 1975 from the Latin word *fractus*, which means wrecked. A fractal antenna be antenna that uses a fractal, self-similar design to make the most of the length, or increase the perimeter (on outer structure or inside section), of material that can transmit or receive electromagnetic radiation within a given total surface volume or area[11].

The field is quite extensively full with many applications from statistical analyses to natural modelling to compression and computer graphics. Scientists and researchers discovered the practical aspect of fractal geometry which makes beginning of research in the field of electrodynamics. To date most efforts have been concentrated and confined in understanding the mathematical background and physical process of interaction between fractal structure waves electromagnetic [8]. These are the geometries which has been used to characterize structures within nature that were not effortless to define with Euclidean geometries. The distance from one end to another end of a coastline, the density of clouds, along with the branching of trees are some examples of such geometries. Now as nature is ahead of the Euclidean geometries, in similar way antennas and antennas arrangement designs are beyond its edge as well.

For proper working of an antenna at all frequencies it must satisfy two criteria:

- It must be symmetrical about a point.
- It must be self-similar, having the equal basic exterior at every scale.

Fractal which satisfies above conditions will show wideband and multiple significant frequencies behavior. Antenna miniaturization is an essential aspect in modern communication system design. With increasing need for compact and small sized transceiver, manufacturer discover it difficult to design smaller antenna. There are several methods offered for reducing the size of an antenna such as changing the radiating patch figure or changing the ground plane and substrate characteristic, which includes introduction of slots in the shining path to raise the length of radiating element, loading the edging of patch with inductive element etc [9]. They decrease the operating frequency by substantial amount but also adjust the radiation characteristics. In modern wireless communication system and with growth of other wireless applications, wider bandwidth, multiband and little profile antennas are in enormous demand meant for both commercial and military applications This fractal geometry which have been worn to model multifaceted objects found in natural world such as clouds and coastlines, Cauliflower, cloud boundaries, mountain range, snowflakes, trees, leaves, ferns shown in figure 2.1. [11]. All Fractal have one imperative feature that is the fractal dimension to determine the roughness, measure of complexity or convolution. Fractal geometry can furthermore be used to describe the uniqueness and simulation of multifaceted shape of certain entities in nature. Triangular fractal antenna consists of unlike isosceles triangles with open angular size and dissimilar height and common vertex. Fractal electrodynamics is single of the major applications of fractals, during which the fractal geometry be united among electromagnetic theory to investigate new class of radiation, propagation, and dispersion problems. Antenna theory and design comprise become one of the most promising area[8] of fractal electrodynamics research. Fractal antennas consists of recurring geometrical structure and capable of designing in numerous shapes, such as Sierpinski carpet, Sierpinski gasket , Minkowski loop , Koch Island etc. These antennas have been broadly studied due to many advantages on basis of multiband, wide bandwidth, and compact size.

Figure 2.1 (a) Tree Fractal (b) Cloud boundaries [12]

III. DESIGN OF ANTENNA

The Prefractal Sierpinski antenna is designed using HFSS tool. It is used to simulate each antenna model including S11 reflection coefficients, radiation pattern, radiation efficiency and Voltage Standing Wave Ratio for studying characteristic parameter of antenna, the antenna designs, and measure results. The antenna substrate is placed above the ground plane shown in figure 3.1, TEFLON is used as a substrate with dielectric constant =2.5, loss tangent =0.001 and thickness h=2.6mm. The design of antenna is used for the operational frequencies of 2.15 GHz which is based on the formulae available from standard books. A return loss of -15.85 db is predicted from graph with return loss bandwidth of 45.1% and VSWR is 2.4 at 2.15 GHz . A typical set of dimensions for antenna design is given in table3.1

Table 3.1 Various parameter of antenna

Parameter	**Size in mm**
Size of substrate (TEFLON)	44×40×2.6 mm
Size of patch	37.5×12.14mm
Size of strip	7×3mm

Size of arms of 1st triangle	40×39mm
Size of arms of 2nd triangle	16×15mm
Size of arms of 3rd triangle	10×9mm
Size of ground plane	44×40mm
Tangent loss of substrate	0.001 (dimensionless)

USING HFFS THE GEOMETRY OF PREFRACTAL SIERPINSKI ANTENNA WAS PREPARED

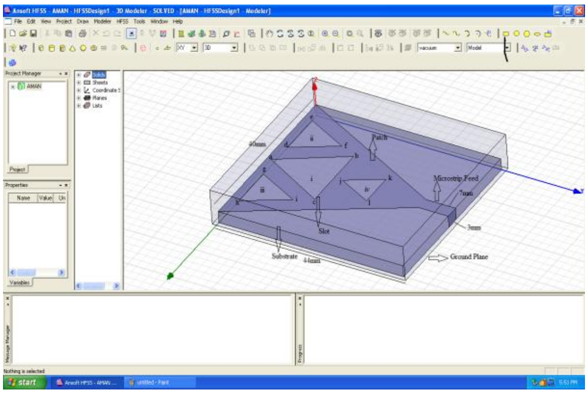

Figure 3.1 Geometry of Prefractal Sierpinski antenna

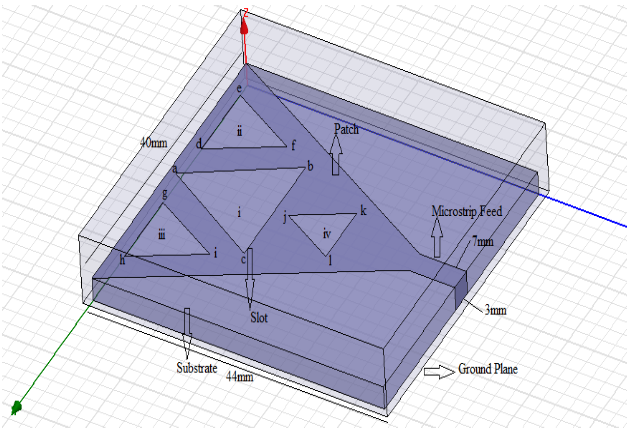

Figure 3.2 Isometric view of Prefractal Sierpinski antenna

IV. 4.RETURN LOSS (RL)

The Return Loss (RL) is a parameter which indicates the amount of power that is "lost" to the load and does not return as a reflection[6]. The waves which are reflected leads to the formation of standing waves, when the transmitter and antenna impedance do not match. Hence the RL is a parameter similar to the VSWR to indicate how well the matching between the transmitter and antenna has taken place. S parameter describe the input-output relationship between ports (or terminals) in an electrical system.

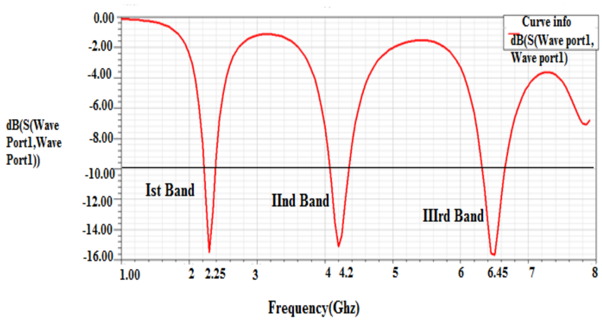

Figure 3.3 S11 Parameter of Sierpinski Prefractal antenna

Table 3.2 Frequency Band Table For given bands

Bands	f_L	f_H	$f_C(f_H + f_L)/2)$	B.W.(f_H-f_L)
1st band	2085MHz	2285MHz	2185MHz	200MHz
2nd band	4185MHz	4285MHz	4240MHz	105MHz
3rd band	5975MHz	6495MHz	6235MHz	520MHz

V. VSWR

The parameter VSWR is a measure that numerically describes how well the impedance of antenna has matched to the radio or transmission line to which it is connected. VSWR stands for Voltage Standing Wave Ratio, and is also referred to as Standing Wave Ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna.[4] The VSWR is always a real and positive number for antennas. The smaller the VSWR is, the better the antenna is matched to the transmission line and the more power is delivered to the antenna. the operational frequency of 2.15 GHz, 4.2 GHz and 6.25 GHz VSWR bandwidth nearly 2.4 is shown in figure 3.4.

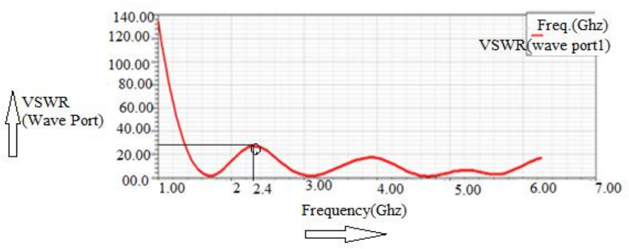

Figure 3.4 VSWR of Proposed Antenna

CONCLUSION

Prefractal Sierpinski antenna with a compact triangular patch using microstrip line feed for tri narrow band wireless communications systems is designed in HFSS and fabricated on TEFLON. The result demonstrates that the proposed antenna with triangular slots and triangular cuts at special positions can generate steady radiation patterns and is capable of wrapping the frequencies demanded by UWB Communication system, RFID, GSM, Wi-Fi and WiMAX. Good agreement between the simulated and measured results further validates the utility of proposed antenna for given applications. Different design parameters with their effects were a studied. For the operational frequency of 2.25 GHz, 4.2 GHz and 6.45 GHz and VSWR bandwidth nearly, a bandwidth nearly 2.4 and return loss up to -15.75db was achieved. Triangular slots and triangular cut used here plays an important role in balancing resistive part and reactive part which affects the impedance matching. Triangular slots at the centre increases radiating edges which results in improved bandwidth. A thick dielectric substrate also plays vital role in increasing the bandwidth.

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