Design and Analysis of Compact Wide MultiBand Fractal Microstrip Antenna for Wireless Applications of 2-16 GHz

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Abstract - In this research, a compact size multiband (WB) wideband fractal microstrip antenna is designed and simulated for wider bandwidth applications ranging from 2 to 16 GHz. The proposed work introduces a methodology that adding of structures minimizes the bandwidth and increases the return loss. Communication systems require small size, wideband and multiband antennas. Fractal geometries have been used to fabricate multi-band as well as broad-band antennas. In addition, fractal geometries can be reducing the size of antennas. In this work, we have investigated a new fractal antenna proposed by researchers with multi-band and broad-band properties. The proposed design is a loaded the 4 iteration of a new fractal geometry to a monopole CPW fed microstrip patch antenna. The simulation is performed via HFSS electromagnetic simulator software. The simulation proves that the proposed antenna is applicable in 2- 16 GHz frequency range.

Keywords-CPW fed Microstrip Antenna, UWB Antenna, UWB Antenna Designing, and Compact Antenna Review on UWB.

1. INTRODUCTION

Antenna plays such a significant role in communication systems and one of the main part of ultra wideband (UWB) communication systems. WB communication systems require smaller antennas with large bandwidth, thus the design, simulation and manufacturing of these antennas are very essential. This is the main reason of wide research on UWB antennas in recent years. There are many techniques; one of the good technique is using fractal geometry to design of wideband antennas. Applying fractals to the antenna geometry allows for smaller size, multi-band and broad-band properties [1-4].Fractals have self-similar structure and can be subdivided into small parts such that each part is a reduced size copy of the main geometry. Self-similarity of fractals provides multi-band and broad-band properties and their unusual shapes provide design of antennas with small size. Fractals have convoluted and serrated shapes with many corners these discontinuities increases the bandwidth and the effective radiation pattern of antennas. Fractals can be placed all along the electrical length in to a small area using their facility of space-filling [5-9].

In this paper, new fractal geometry is proposed. By applying this fractal generator to proposed antenna elements, we have achieved a wideband and multiband antenna.

The Finite Element Method (FEM) based electromagnetic simulator HFSS has been used for the design and simulation of the proposed antenna. This new fractal antenna is applicable in 2 GHz-16 GHz. Also, the radiation patterns are studied in multi frequencies.

2. ANTENNA DESIGN

In general, the bandwidth of a microstrip patch antenna is not very wide because it has only one resonance mode. Thus, to design a wideband radiator, two or more resonant parts with each part operating at its own resonance is essential, and the overlapping of these multiple resonances mode may lead to multiband or broadband operations. Therefore, this design is chosen to generate two or more resonance bands for achieving wide bandwidth and multiband. In addition, the conventional wideband monopole antenna using a solid ground plane on the further side, in this design, the two grounds were designed on the same plane of the monopole as shown in Fig. 1. The design skills are introduced to obtained wideband accompanied with good impedance matching above the entire operating band. The basis of the monopole antenna is a rectangular patch, which has the specification of length L_{p2} and width W_{p3}, and is produce with two inverted L-shaped structure strips from the patch's upper two sides. It comprises both the vertical and horizontal structure with dimensions of L_{p1} x W_{p1} and L_{p2} x $W_{p2,}$ respectively.

As for the ground plane, distinct the general use of a solid rectangular plane for a microstrip line fed monopole antenna, ground planes are set in from the patch's left and right sides on the same plane of patch to provide the CPW feed. The overall size of the antenna is 25x25x1.6 mm^3, and each of the surrounded grounds has a vertical section of 25 mm as well as a horizontal section at the upper and bottom structure of 10.5 and 10.6 mm, respectively.

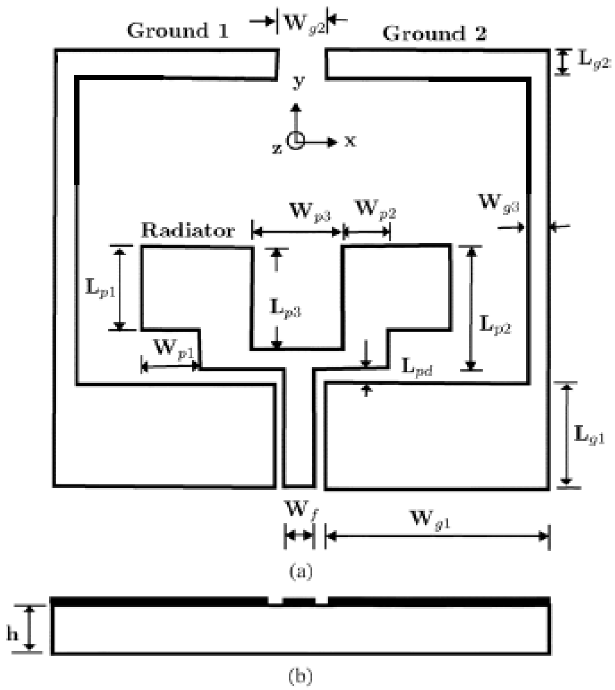

Fig. 1.The proposed wideband multiband microstrip antenna.

The width of the CPW microstrip feedline is fixed at 3.0 mm to achieve 50Ω characteristic impedance. Since the antenna is surrounded by a ground plane for reducing the antenna area, the small gap between the patch geometry and the ground plane is a major factor to cause very strong capacitive coupling. The horizontal feed section (x-axis) is separated from the ground by a gap of 0.4 mm (Fig. 1). The detailed dimensions of the proposed wideband and multiband antenna are listed in Table I. This UWB antenna was simulated using HFSS software by keeping the substrate of a 1.6 mmthick, FR4_epoxy substrate permittivityof 4.4 and a loss tangent of 0.02.

TABLE I Design Parameters of the Proposed Compact Wideband and Multiband Microstrip Antenna Shown in Fig.1

Parameters	L_{p1}	L_{p2}	L_{p3}	L_{g1}	L_{g2}	L_{pd}	
Unit(mm)	5	7	6.5	8	1	0.8	
Parameters	W_{p1}	W_{p2}	W_{p3}	W_{g1}	W_{g2}	W_{g3}	W_f
Unit (mm)	2.5	2.5	5	10.6	4	1	3

3 SIMULATION AND RESULTS

The electromagnetic waves solver, Ansoft HFSS, is used to investigate and optimize the proposed antennas configuration. Fig. 3, shows the simulated return loss of the proposed antenna with the iteration optimized parameters. Obviously, the simulation results show wide bandwidth of around 4.8- 5 GHz with four resonant bands at 2.23, 6.05, 10.66 and 15 GHz with return loss of -20.44, 19.03, 35.89 and -25.06 dB.Fractal geometries are made by reducing the structure to half of its base geometry upto four times to achieve the proposed design. Comparative results are mention in Table II.

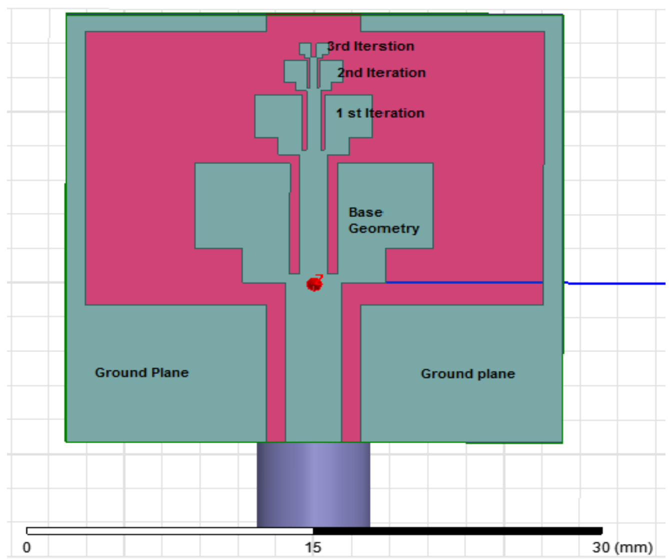

Fig.2 Proposed geomtery with 3rd Iterstion of fractal.

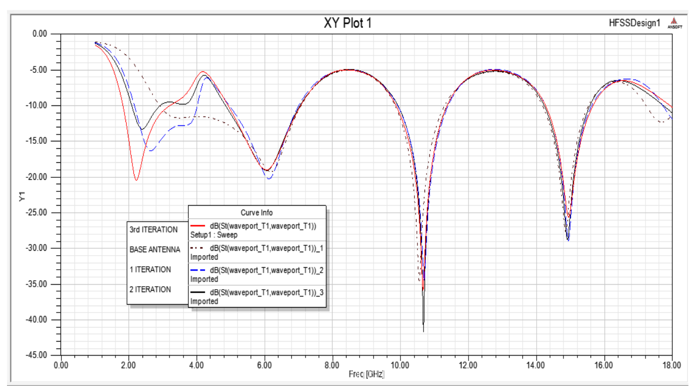

Fig.3Return loss Vs frequency coparison to basic geometry,1st, 2nd 3rd Iteration of fractal antenna.

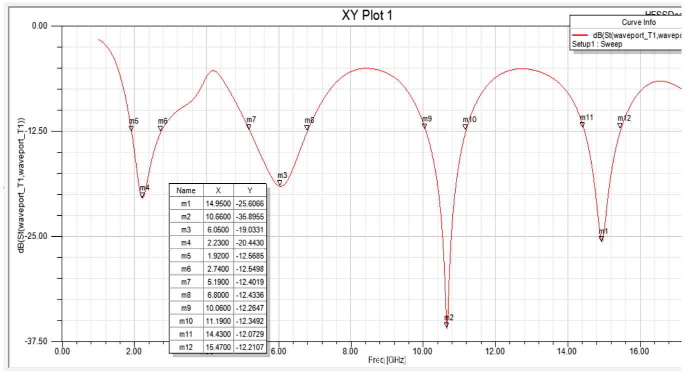

Fig.4return loss for 3rd Iterstion of fractal.

Table II Comparative results

Geometry	Resonating freq (GHz)	S_{11} (dB)	Bandwidth (GHz)
Antenna Base Geometry	6.05 10.6 15	-19.03 - 35.89 -29.06	3.65 1.2 1.1
1st Iteration	2.3 6.05 10.6 15	-16 -19.03 - 35.89 -29.06	1.8 3.65 1.2 1.1
2nd Iteration	2.25 6.05 10.6 15	-13.45 -19.03 - 35.89 -25.06	0.4 3.65 1.2 1.1
3rd Iteration	2.23 6.05 10.6 15	-20.44 -19.03 - 35.89 -25.06	1 3.65 1.2 1.1

4 CONCLUSION

In this paper, a compact WB and multiband microstrip antenna is proposed. The measured results of the simulated antenna show stable radiation patterns over the whole of the wide band and for extra bands as well. The good impedance matching characteristic, constant gain, and an omnidirectional radiation patterns over the entire operating range 2-16 GHz make this antenna a good choice for WB applications.

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