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Design of Fractal Antennas Using High Frequency Structure simulator

N.S.Murtisarma, S.P.Venumadhava Rao and N.Chandana

Sreenidhi Institute of Science and Technology, Hyderabad.

Abstract: In this paper, modelling and simulation of the designed antenna by using Ansoft HFSS software is described. The various steps for creating antenna model is also presented in detailed. Though several applications of Antennas as patch, horn, wire, Arrays are in practice, Fractal antennas find new trend.

Key words: HFSS,Fractal antenna, simulation, design.

1.Introduction

The fractal antennas [22]are multiband antennas and small in size. It is found that increase in number of fractal iterations, number of resonant frequencies also increases. The design parameters were calculated by using closed form equations available in text books and various technical reports[1-15]. Simulation model is created by using Ansoft HFSS simulation software and various parameters were optimised for achieving the desired goal. HFSS (High Frequency Structure Simulator) HFSS is an interactive simulation system whose basic mesh lement is tetrahedron. This allows us to solve any arbitrary 3D geometry; especially those which complex curves and shapes in a fraction of the time it would take using other techniques. In general this requires Microsoft Windows XP (32/64), Windows 2000, or Windows 2003 Server. , Pentium –based computer with Minimum RAM of 128MB , 8MB Video Card and Mouse or other pointing device. Several applications of HFSS includes areas in Antenna, microwave and signal integrity. Though several applications of Antennas as patch, horn, wire, Arrays are in practice, Fractal antennas find new trend. Hence these are selected for simulation.[16-38]. Some basic tips to start with HFSS are as follows.

A. Opening an HFSS project

1. In an Ansoft HFSS window, select the menu item File > New.
2. Select the menu Project > Insert HFSS Design.

B. To open an existing project

1. In an Ansoft HFSS window, select the menu File > Open. Use the Open dialog to select the project.
2. Click Open to open the project

C. Opening an Existing Project from Explorer

One can open a project directly from the Microsoft Windows Explorer. To open a project from Windows Explorer, one of the following actions are essential.

1. Double-click on the name of the project in Windows Explorer.
2. Right-click the name of the project in Windows Explorer and select open from the shortcut menu.

2 Design and Simulation of Fractal Antenna Using HFSS

The different stages in designing Fractal Antenna in HFSS are as follows.

A. First double click on the HFSS icon → click on File → select New Project → Project on the toolbar → select Insert HFSS Design. We obtain the representation of the X, Y, Z axis.

B. In next step draw 5 circles with radii 43mm, 21.5mm, 10.75mm, 5.375mm, 2.75mm (outer circles) and then draw 4 more inner circles with radii 41.4 mm,19.9 mm, 9.15 mm, 3.775 mm around the centre of the axis.

C. Shift the circles such that they have a common point.

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D. Rotate the design to the X-axis such that Z-plane is perpendicular to it.

E. Subtract the inner circles from the outer circles to form 5 rings and are united.

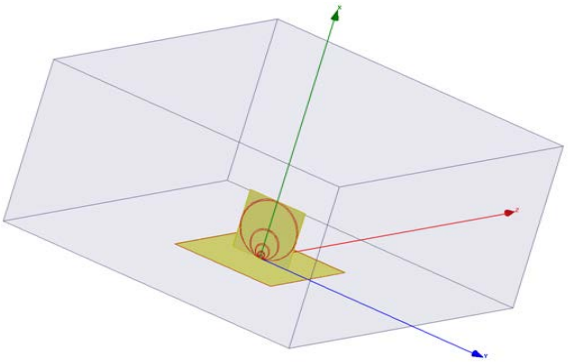

Figure 1: Final design of a fractal antenna

F. Assigning FR4 substrate (dielectric constant 4.4)

G. Assigning ground plane

H. Now we create two cylinders of perfect electric conductor (PEC) and Teflon to make inner and outer part of the connector and circle at the bottom and assigned wave port to it.

I. Created radiation box and assigned radiation boundary to it.

B. Simulation

a. After the designing of the Fractal antenna the simulation is carried out.

b. Firstly, Validation check is performed to observe warnings and errors if any in the design.

c. Next, the set up is assigned to the antenna, sweep in the range of 0.5 to 6 GHz. With step size of 0.1 GHz.

d. After that the antenna is simulated.

e. The required antenna parameters (VSWR, Radiation pattern, Return loss) graphs are observed in HFSS.

C. Optimisation Using HFSS

In HFSS Software, once we have defined the co-ordinates of the design we can develop a 3D view of the Fractal and simulate to obtain various characteristics (Return loss, Radiation pattern, Gain etc.). If the characteristics don't match with the

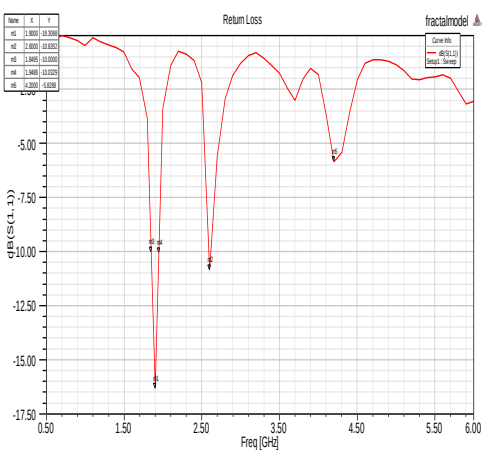

Figure 2 VSWR and Return Loss Characteristics

expected one, the dimension of the rings, thickness of

the circles and the thickness of the substrate are varied in small steps and re-simulated until required characteristics are obtained. Thus, optimization of parameters like width of rings, radius of the inner rings and their centre positions play a key role in antenna performance.

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To achieve the desired performance of the antenna, various design parameters of the fractal antenna were optimised. If the thickness of the circles is increased, then the return loss increases. As the thickness of the substrate is increased, return loss is greater than -10 dB.

3. SIMULATION RESULS and discussion

The simulation results obtain after optimizing the fractal using HFSS are presented here. From the Figure 2 it can be observed that the antenna is resonating at 1.9GHz and 2.6GHz. Similar result is obtained for VSWR.Achieved bandwidth centred at 1.9GHz is 1.86 GHz to 1.92GHz and at 2.6GHz is 2.58GHZ to 2.65GHZ.

Conclusions

A novel method for designing a wideband monopole antenna based on the principles of fractal Sierpinski Gasket and circular disk monopole has been simulated. The discrete structural properties of these multiple ring monopoles enables a well defined current path which gives better control of the radiation pattern than that of the circular disk monopole at high operating bands.

The fractal antenna can be used at 1.9GHz and 2.6GHz, their applications being PCS, GSM and WiMax. Hence it is a multiband antenna. At 4.2GHz the obtained frequency value is -5.8dB and it can be improved by further optimization.

Its structural similarity to the fractal Sierpinski Gasket and parany monopole antennas also results in log-periodic resonant behaviour. Larger bandwidths and improved patterns are achieved by further optimization of its design parameters

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