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Analysis the behavior of Sierpinski Carpet and Fractal Tree Antennas

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Abstract

In this paper we design and analysis the result of the 4th iteration of Sierpinski carpet fractal antenna and Fractal tree antennas. The proposed antenna is designed on FR4 epoxy substrate with dielectric constant of 4.4 and fed with 50 ohms micro strip line. In our paper there is a comparison between fractal tree and sierpinski carpet fractal antenna. The Dimensions for the sierpinski Carpet and fractal Tree antenna are 16mm*18mm*1.6mm. The antenna structure is simulated using An Soft HFSS software. The antennas characteristics such as return loss, radiation pattern and VSWR of the antenna are analyzed and presented. The proposed fractal antenna can be used in the frequency range from 2-20 GHz. In our purposed work the simulated result of sierpinski carpet fractal antenna is much better than the fractal tree antenna.

Keywords: *Microstrip Antenna, Fractal, Sierpinski Carpet Fractal Antenna (SCFA).*

I. Introduction

Wireless communication has been developed widely in recent years. Future communication devices will aim to provide video, images, data communication, anytime anywhere around the world. This indicates that the future communication devices must meet the requirements of multiband or wideband in order to cover all possible operating bands, at the same time they should be small enough to be placed inside the communication systems or communication devices. Fractal antennas [1] can be used for this purpose. Fractal antennas can be used to find the best distribution of current within a given volume in order to meet a particular design goal. There are several advantages as in [2] of these fractal devices including reduction of resonant frequencies, smaller size and broadband width as well as low profile, low weight, conformal to the surface of objects and they have easy production.

II.The Purposed Antenna Configuration

The square patch was selected for initial design. Fig1 shows the sirpinski carpet fractal antenna and fractal tree antennas fourth iteration.

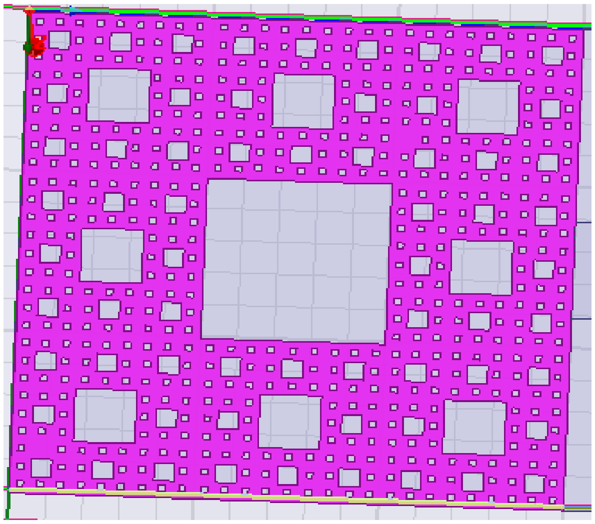


Figure 1(a): 4th iteration of sirpinski carpet fractal antenna

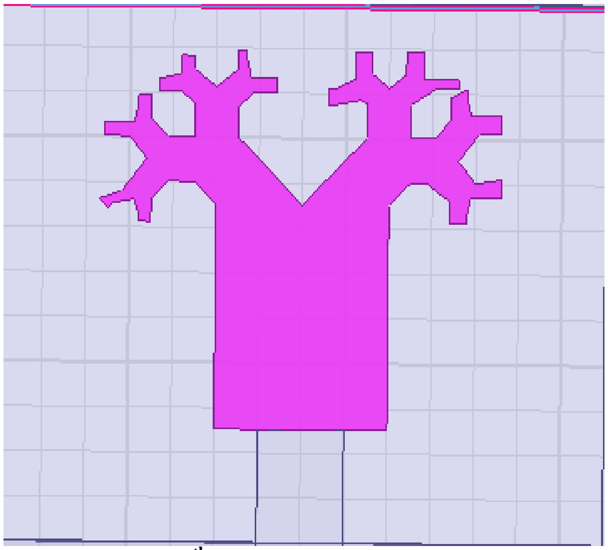


Figure 1(b): 4th iteration of fractal tree antenna

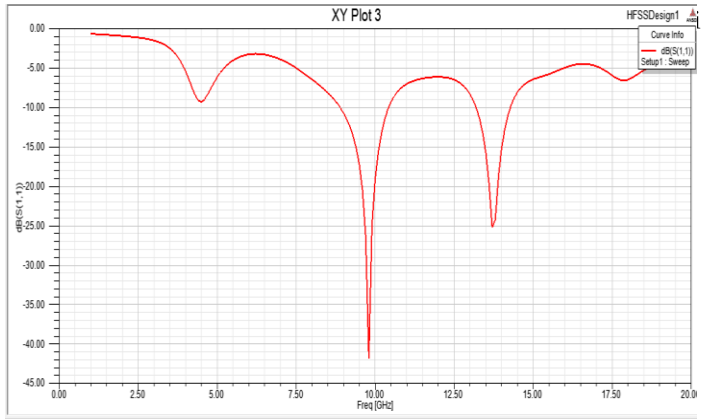
III. Antenna Design

The design starts with Sierpinski Carpet Planar Antenna. The first basic rectangular patch is designed. In the first iteration the basic square patch is segmented by removing the middle square from it, by taking scale factor 1/3. For second iteration segments are done on remaining eight squares following the scale factor of 1/3. The same procedure is used for further iterations with same scale factor. By using this method we have designed four iterations as shown in Figure 2. This basic rectangular patch is designed on a FR4 substrate of thickness 1.6 mm and relative permittivity of 4.4.

We can use two methods. One is design a patch and then cut it in a tree shape. And the second method is , takes a initial segment, divide it by a scaling factor, move at an angle and place at the top of the initial segment. The same pattern is repeated to construct the tree of any order. Here different variable parameters of the fractal are the size of the initial segment, scale factor, branching angle and number of iterations. Increase in width of main stem as well as branches, reduces return loss and improves the bandwidth. Length of main stem shifts one of the frequencies, length of the branches shifts remaining frequencies. In short the Size of the first segment determines the one of the resonant frequency of the antenna. Scale factors may decide the ratio between the successive resonant frequencies. The branching angle also affects the coupling. However it does not affect the ratio of resonant frequency if the lengths and widths of the branches are not dependent on the angle. [8] Fractal geometry are generated in an iterative fashion, leading to self structure .The tree geometry start with a stem allow one of its ends to branch off in two directions .In the next stage of iteration ,each of these branches allowed to branch off again. The process is continued endlessly.

IV. Return Loss

The return loss for the sierpinski carpet fractal antenna is given in fig 2(a).



carpet fra

Figure 2(a): Return loss for sierpinski carpet fractal antenna

The return loss for fractal tree antenna is given in fig 2(b).

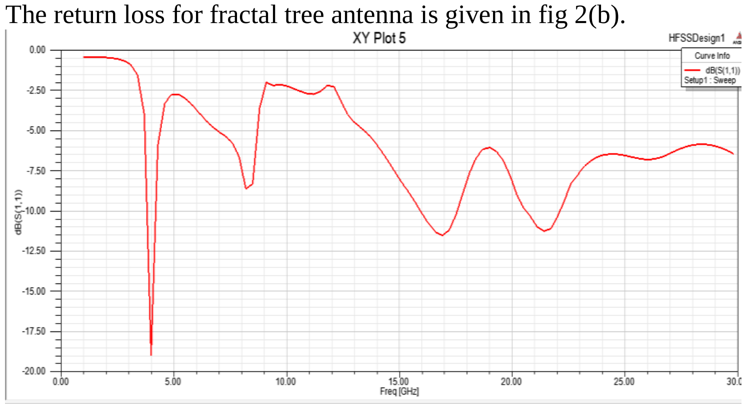


Figure 2(b): return loss for fractal tree antenna

V. VSWR

The VSWR for the sierpinski carpet fractal antenna is given in fig 3(a).

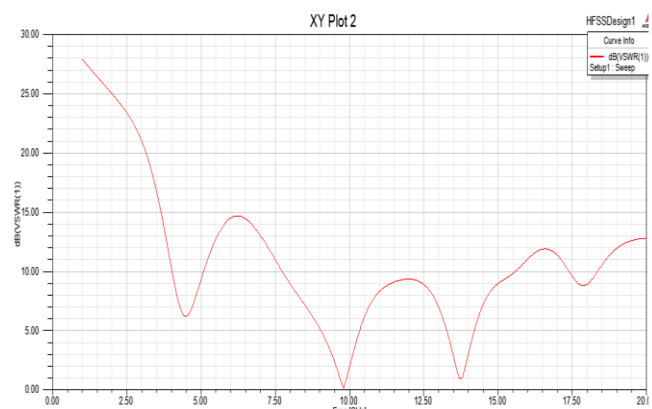


Figure 3(a): VSWR for sierpinski carpet antenna

The VSWR for fractal tree is given in fig3(b).

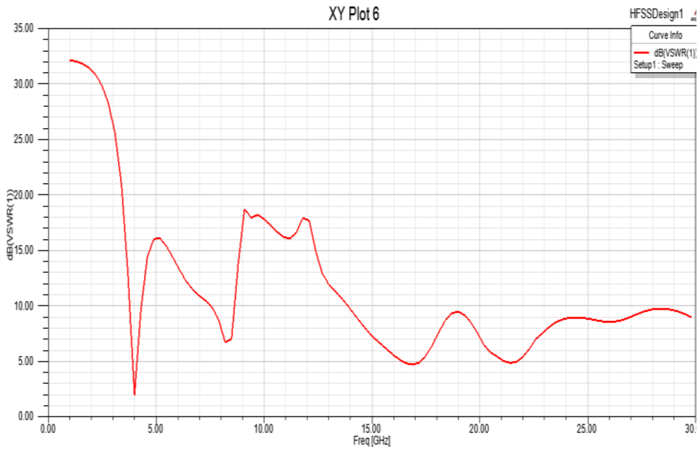


Figure 3(b): VSWR for fractal tree antenna

The measured values of the return loss and the VSWR are given in table 2 and 3 which are given below:

Table 3: For sierpinski carpet fractal antenna

Ref. no.	Resonating Frequency(GHz)	Return Loss(db)	VSWR(db)	Bandwidth(%)
1	9.6	-20	1.6	-
2	9.9	-24	0.9	20
3	10	-19	1.9	-
4	13.6	-19	1.8	-
5	13.8	-24	1	-

Table 4: For fractal tree antenna

Ref. no.	Resonating Frequency(GHz)	Return Loss(db)	VSWR(db)	Bandwidth(%)
1	4	-21.25	1.5	12.5
2	16	-10	5.5	-
3	16.3	-10.8	5	-
4	16.6	-11.3	4.8	-
5	16.9	-11.5	4.7	-

VI. Radiation pattern

The radiation pattern for sierpinski carpet antenna is given in fig4(a).

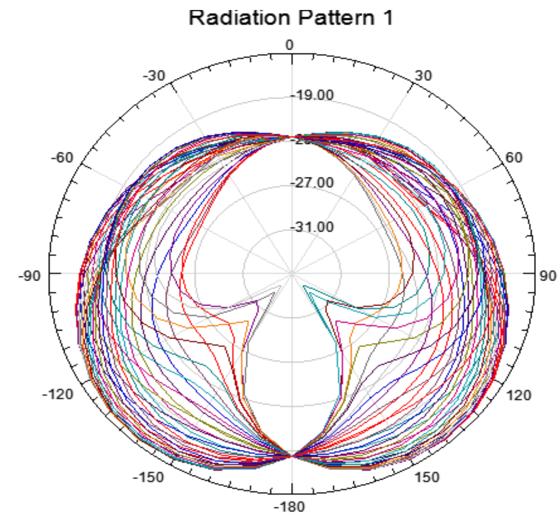


Figure 4(a): Simulated radiation pattern for sierpinski carpet antenna

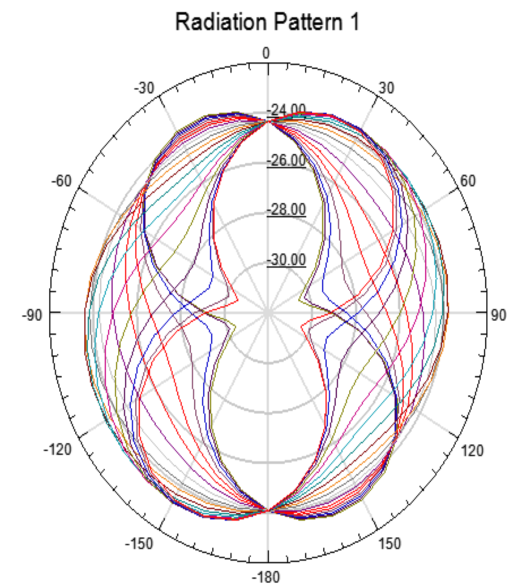


Figure 4(b): Simulated radiation pattern for fractal tree antenna

Fig 4(a) and (b) shows radiation patterns of sierpinski carpet fractal antenna and fractal tree antenna. It is observed that the E-field pattern is omni directional with low cross polarization level less than -27db for sierpinski carpet and for fractal tree antenna E-field pattern is near omni directional with polarization level less than -25db.

VII. Conclusion

The sierpinski carpet and fractal tree antennas are designed and its performance characterstics are analysed.The simulated result of the sierpinski carpet fractal antenna exhibit minimum return loss,omini directional radiation pattern, wide impedence bandwidth, VSWR<2, which is much better then the simulated result of the fractal tree antenna.

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