Printed Fractal Antennas for Multi and Wide-Band Applications

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Abstract:

Study of the CPW-fed for monopole antenna and slot antenna with fractal shape radiator element is proposed. By using fractal slot, new design antennas have the wide measured return loss bandwidth. Besides, the omnidirectional radiation patterns of the design antennas cover the entire frequency range have been obtained. Several properties of the antennas such as impedance bandwidth, radiation patterns and gain have been investigated numerically and experimentally in detail.

1. Introduction

Modern and future wireless systems are placing greater demands on antenna designs. Many systems now operate in two or more frequency bands, requiring dual- or triple-band operation of fundamentally narrowband antennas. A variety of techniques have been used to create multiband antennas. Several fractal geometries have been introduced for antenna application with varying degrees of success in improving antenna characteristics. Some of these geometries have been particularly useful in reducing the size of the antenna. These are low profile antennas with moderate gain and can be operative at multiple frequency bands.

Structure simplify, multiband and wideband found to main focal that antenna design in recent years, because the self-similar characteristic of the fractal antenna, and it made the antenna have limitless and multiband characteristics, so to utilize the fractal characteristic of the antenna could be designed and developed and be attracted attention gradually [1-2]. Several interesting antenna designs with diverse geometric configurations for multiband and wideband have been widely studied, such as a monopole antenna, a dipole antenna, and a slot antenna etc [3-5]. Because their wide impedance bandwidth, omnidirectional radiation pattern, compact and simple structure, low cost and ease of construction. In this paper, we proposed the CPW-fed for monopole antenna and slot antenna with the way by four stages rectangular fractal shapes, they could be applied to the microstrip antennas, and a limitless wideband characteristic with the fractal improves the narrow band of the microstrip antenna.

2. Antenna Design

Figs. 1 and 2 show the geometry of the two proposed antennas for wideband applications. They are printed on the FR4 substrate of thickness (h) 1.6 mm and relative permittivity 4.4 and have a dimension of 58 x 52 mm^2 in this study. The fractal shape monopole antenna (antenna 1) has a rectangular fractal shape and a CPW-fed with edge length (L_f) of 15.4mm and width (W_f) of 2.93mm, and gap distance (S) of 0.3mm between the feed line and the ground plane; The fractal shape slot antenna (antenna 2) with the rectangular slot and a CPW-fed is like the antenna 1. The widths and lengths for both feeds are about one third of the fractal size (maximum length edge, 10.8mm; minimum length edge, 0.4mm) and their lengths are close to but less than the quarter wavelength measured at the lower frequency edge. Other dimensions of the proposed antennas are W_1 = 32.4 mm, W_2 = 24.35 mm, W_3 = 52.2 mm, L_1 = 30.6 mm, L_2 = 36.6 mm, L_3 = 52 mm .The dimensions of the antenna were firstly studied by Ansoft HFSS simulation electromagnetic software, and then verified by experiment.

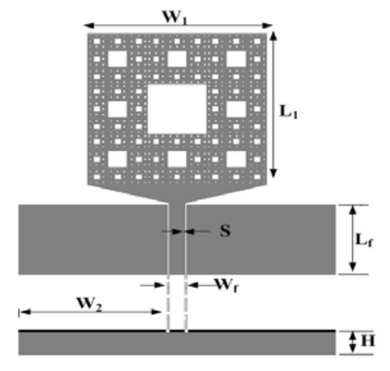

Figure 1: The configuration of the proposed antenna 1

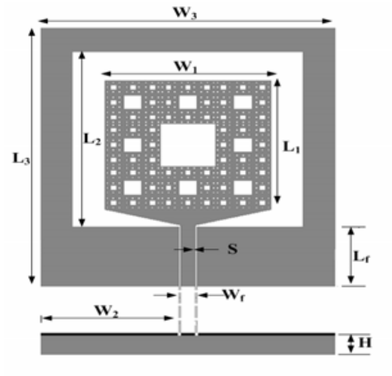

Figure 2: The configuration of the proposed antenna 2

3. Simulated and Measured Results

A. Fractal Shape Monopole Antenna

Fig. 3 shows the simulated and measured return loss of the proposed antenna 1. The return loss is measured by using the HP8720C vector network analyzer. The proposed antenna measured in NTUT 3D antenna chamber. The measurement chamber could be measured from 0.7GHz to 20.5GHz and covered wide band, its total dimension of 3.25 m × 2.82 m× 6.65 m. The measured bandwidth of proposed antenna 1 is covered five resonance modes within 1.7GHz ~ 10.35GHz.

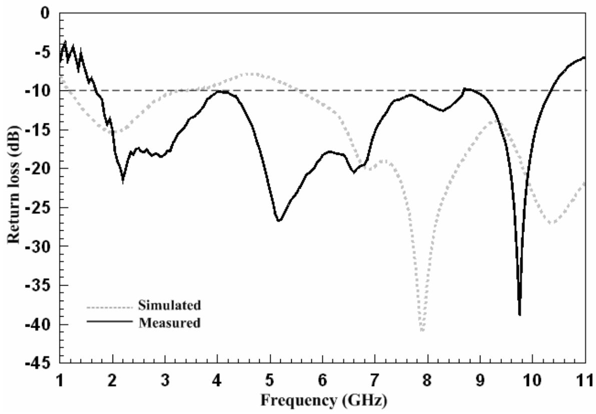

Figure 3: The simulated and measured return loss of the proposed antenna 1

The measured gain of the proposed antenna1 is above 4 dBi from 2.1 to 2.6 GHz in the lower frequency range. When the frequency increases from 5 to 5.8 GHz, the peak gain is higher than 5 dBi, another frequency range from 9.3 to 10.6 GHz also have a high peak gain changed range from 4 to 7dBi. Figs. 4 and 5 show the measured radiation patterns of proposed antenna 1 in x-z and y-z planes at 2.5GHz, 5.2GHz and 9.8GHz, respectively.

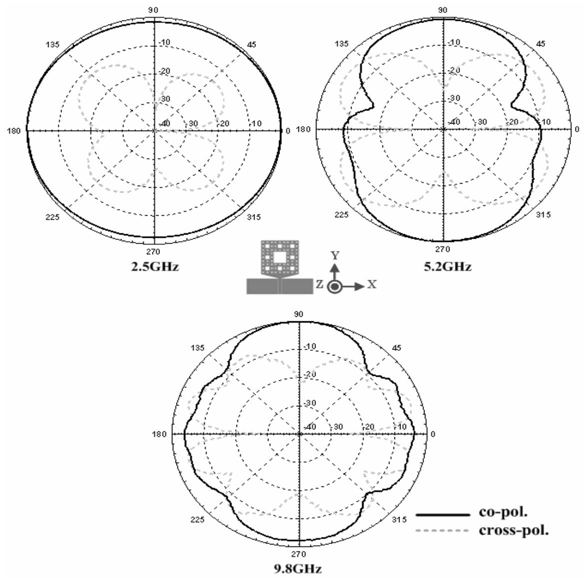

Figure 4: Measured x-z plane radiation patterns

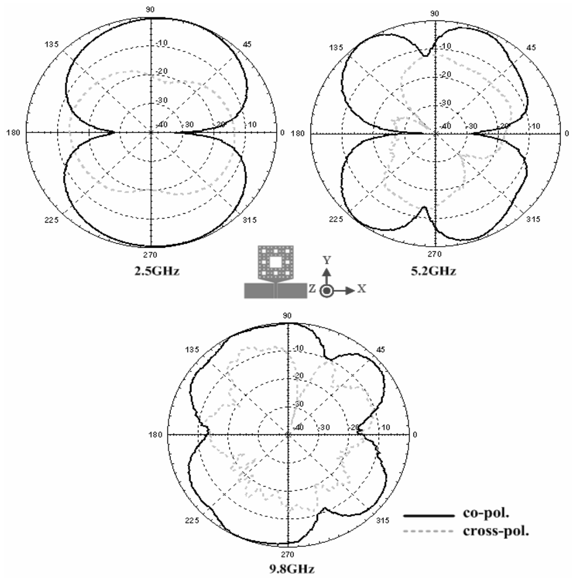

Figure 5: Measured y-z plane radiation patterns

B. Fractal Shape Slot Antenna

Fig. 6 shows the simulated and measured return loss of the proposed antenna 2. Obviously, the results in between experiment and simulation are in fairly good agreement. The impedance bandwidth of proposed antenna 2 is covered five resonance mode. The first mode from 1.95GHz to 2.8GHz, the second mode from 3.85GHz to 4.4 GHz, the third mode from 4.4GHz to 6.4GHz ,the fourth mode from 6.65GHz to 8.3GHz, and the fifth mode from 9.75GHz to 10.9GHz, respectively. It can also be seen that the peak gain is above 5 dBi from 2.1 to 2.6 GHz in the lower frequency range. When the frequency increases from 5 to 5.8 GHz, the peak gain is higher than 4 dBi, and frequency range from 9.3 to 10.6 GHz has a peak gain changed range from 1.9 to 4.7dBi.

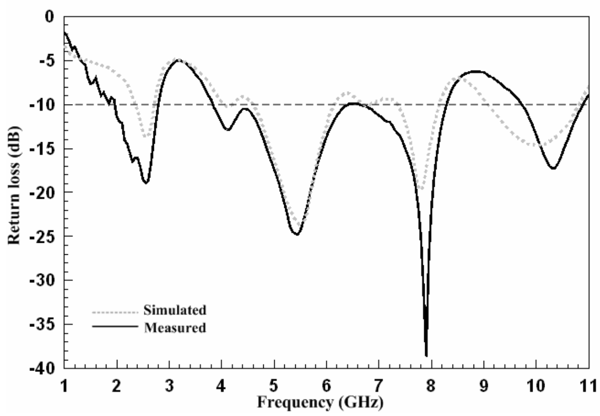

Figure 6: The simulated and measured return loss of the proposed antenna 2

Figs. 7 and 8 show the measured radiation patterns of proposed antenna 2 in x-z and y-z planes at 2.5GHz, 5.2GHz and 9.8GHz, respectively. It is noticed that the y-z plane pattern is like antenna 1. The x-z plane pattern of antenna 2 is omnidirectional at 5.2GHz and distorted slightly at 2.5 GHz and 9.8GHz. So the radiation patterns are generally omnidirectional over the entire bandwidth, similar to a conventional antenna.

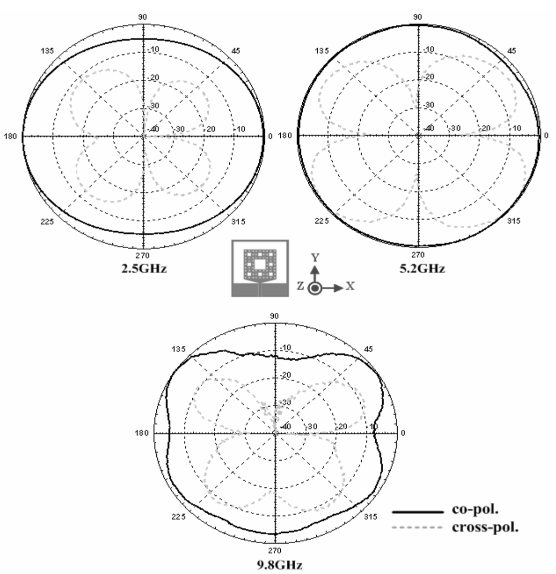

Figure 7: Measured x-z plane radiation patterns

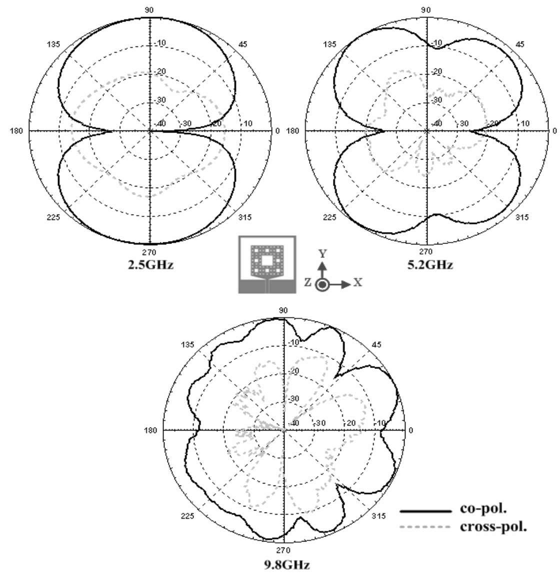

Figure 8: Measured y-z plane radiation patterns

4. Conclusion

Two CPW-fed printed fractal shape antennas have been developed and both of them can achieve wide bandwidths and stable radiation patterns across the whole bands. From the investigation of various UWB antennas, it is found that the feed and the fractal make a strong effect on the antenna's impedance bandwidth and radiation patterns. Experimental results show that by choosing fractal shape and tuning their dimensions, good measured gain and stable radiation patterns can be obtained.

References

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