A Modified Fractal Square Loop Slot Antenna with Capacitive Coupling Fed by CPW

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1. Introduction

Antennas are important for RF front ends of modern wireless and mobile applications. There have been many requirements of antenna designs for high performance, compact size, low profile, etc. There are varieties of approaches that have been developed over the years, which can be utilized to achieve one or more of these antenna design objectives. Lately, the term of the fractal geometries was originally coined by Mandelbrot [1] to describe a family of complex shapes that have self-similarity or self-affinity in their geometrical structure. In literature reviews, we have found an advantage of the fractal geometries, which support the attributes of compact size by using the fractal technique, known as Koch monopole antennas [2]. This fractal antenna is created by iterating the initial triangle pulse through a monopole antenna. Then, a miniaturization of loop antenna using fractal concept, known as Minkowski square loop antenna [3], and other antennas [4-6] were created by using fractal concept to miniaturize the antennas.

In this paper, the modified fractal square loop slot antenna with coplanar-waveguide fed is presented. A technique of fractal geometry to generate the initial generator model in the slot square loop has been performed, resulting in antenna operation for the application of WLAN IEEE 802.11 b/g 2.45 GHz. However, several characteristics of modified fractal square loop slot antennas will be investigated by simulation using the full wave method of moments (MoM) software package from IE3D. The experiments of the fabricated antenna prototype have also been performed. The radiation patterns of the proposed antenna will be also evaluated.

The organization of this paper is as follow. In section 2, a brief explanation on the designing configuration of the modified fractal square loop slot antenna will be given. Then, investigation and experiment of the properties for the proposed antenna will be discussed in section 3. Finally, the results are discusse d in section 4.

2. Antenna Design

Fig. 1(a) shows the geometry of the fractal slot antennas A, B, and C, which are developed by modifying the Minkowski fractal concept in [7] together with co-planar waveguide fed. The presented antennas are created by generating the initial generator model [7], as shown in Fig. 2, applied at each side of inner square slot loop antenna. All of antennas are fed by coplanar waveguide line at 50? , which use the capacitive coupling with the fractal square loop slot. It consists of a strip width w_f and a gap g, as shown in Fig. 1(a). The proposed antennas are fabricated as illustrated in Fig. 1(b). The FR4 dielectric substrate is chosen for implementing the antennas with thickness (h) 1.6 mm, relative permittivity (ε_r) = 4.4 and loss tangent of 0.019. The 50? SMA connector is used to feed the antenna at the CPW line, which the optimal parameters of the proposed antennas are summarized in table 1.

3. Simulation and Experiment

In this section, the attribution of return losses, radiation patterns, and gains occurred on the proposed antennas are investigated and experimented. The simulated and measured results of return losses of antennas A, B, and C agree well as illustrated in Fig. 3. This figure shows that the resonant frequencies of antennas A, B, and C are similarly occurred at the frequency of 2.45 GHz. It can be clearly seen that the dimension of radiating slot of the antenna C is smallest due to the longest physical, while the dimension of radiating slot of the antenna B is smaller than the antenna A, resulting in the longer physical length than the antenna A. Therefore, the antenna C is smaller dimension than the antenna A about 30%. Moreover, the radiation patterns are measured at 2.45 GHz, as depicted in Figs. 4. The radiation patterns are similar to the bi-directional radiation patterns at the resonant frequency 2.45 GHz. In the XZ-plane and YZ-plane, it can be obviously seen that the magnitudes of antennas A, B, and C are approximately occurred at 0 and 180 degree. The peak gain of simulated and measured results of the antennas A, B, and C are about 2 dBi at the resonant frequency 2.45 GHz. The return loss, bandwidth, gain, and relative dimension are summarized in table 2.

4. Conclusion

A Modified fractal square loop slot antenna with capacitive coupling fed by CPW has been proposed. The dimension of antenna C can be reduced approximately 23% compared with the antenna A. Furthermore, the radiation patterns at the resonant frequency are similar to bi-directional.

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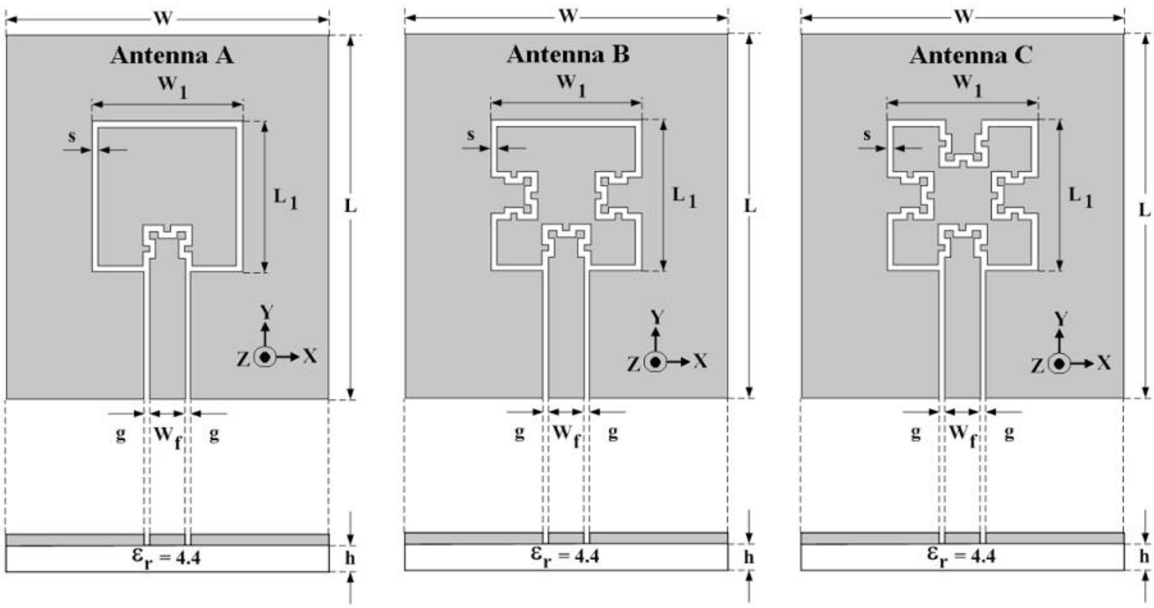
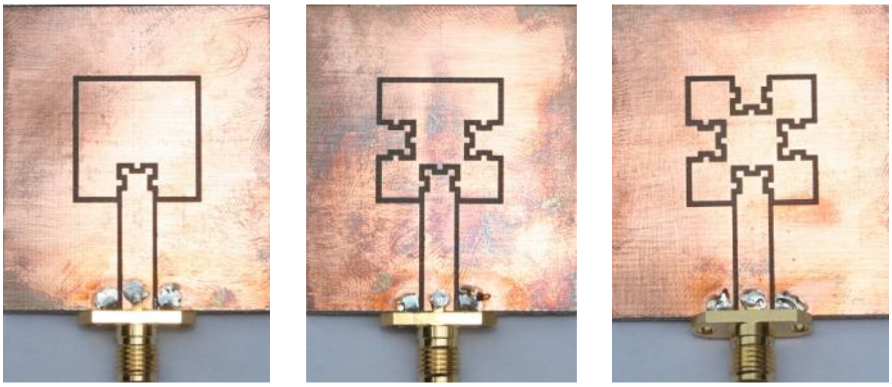


(a)



(b)

Figure 1: The proposed antennas (a) schematics and (b) prototypes.

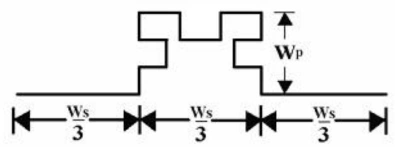


Figure 2: The initial generator model for the proposed antenna.

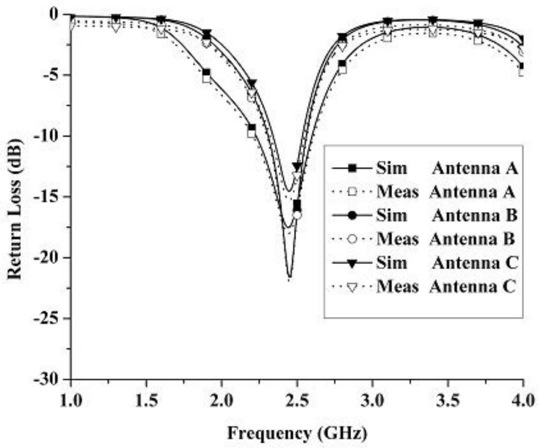


Figure 3: Simulated and measured return losses of the proposed antennas.

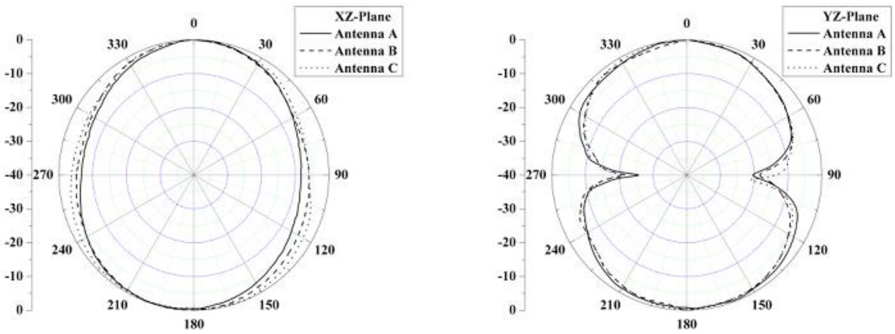


Figure 4: Measured radiation patterns of the proposed antennas at the resonant frequency for (a) XZ-plane and (b) YZ-plane.

Table 1: Summary of parameters for the proposed antennas.

Parameters (mm)	W	L	W_1	L_1	W_p	s	W_f	g
Antenna A	44.80	55.69	24.80	24.80	6.48	0.74	6.09	0.87
Antenna B	40.24	50.92	20.24	20.24	5.16	0.74	4.69	0.67
Antenna C	38.93	49.75	18.93	18.93	4.69	0.74	4.19	0.60

Table 2: Summary of return loss, bandwidth, gain, and relative dimension.

		Antenna A	Antenna B	Antenna C
Resonant Frequency (GHz)	Simulated	2.45	2.45	2.45
	Measured	2.44	2.44	2.45
Return Loss (dB)	Simulated	-18	-22	-15
	Measured	-18	-22	-16
%Bandwidth	Simulated	15.14%	10.28%	7.95%
	Measured	15%	10%	8%
Gain (dBi)	Simulated	2	2	2
	Measured	2	2	2
Relative dimension (%)	Simulated	-	18.38%	23.66%
	Measured	-	18.38%	23.66%