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Design And Study Of Perturbed Julia Multiband Fractal Antenna For Wireless Applications

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Abstract

In this paper, a Julia multiband fractal is designed for use in wireless communication applications. The proposed antenna contains Julia set embedded on FR epoxy substrate with thickness 1mm. Perturbations in the Julia fractal is also studied. The antenna has different characteristics and values because of perturbations.

Keywords: Fractal, Julia set, multiband antenna

1. Introduction

A wireless communication technology has two goals – to operate at multiple frequency bands and make device portable. Portable antennas always include several antennas inside small mobile terminals. Design of such system is a big challenge. Antenna geometries such as rectangle [1], circles [2] or ellipses [3] possess capabilities to serve applications that require large data rate. Multiband wireless services are provided by F-shaped slot antenna [4], circular radiating patch antenna with a rectangular slit [5], microstrip fed slot antenna with a complimentary stub on a single dielectric medium [6], modified three circular ring monopole antenna [7], cylindrical dielectric resonator antenna [8], antenna using PIN diodes [9], CPW fed multiband antenna [10]. Various operating bands such as WLAN/WiMAX, GPS/WiMAX/WLAN, LTE/GSM/UMTS, TD-LTE/WLAN/WiMAX are covered in these literatures.

Section II will demonstrate the construction of the Julia fractal. Section III describes the Julia multiband fractal antenna. Performances are discussed in section IV.

2. The Julia Set

The quadratic mapping produces quadratic Julia sets.

$Z_{n+1} = Z_n^2+c$ (1)

In this z vector (z= a+ib where a and b are real numbers) will assume all the complex plane values, ‘c’ is often known as a complex number but it is kept constant for any Julia set. That is to say, an infinite number of Julia sets are described each for a given c value, but those with smaller c values ($|c| <=2$) are especially graphically involved. Example of Julia fractal for c = -0.3-0.05i is shown in Fig 1

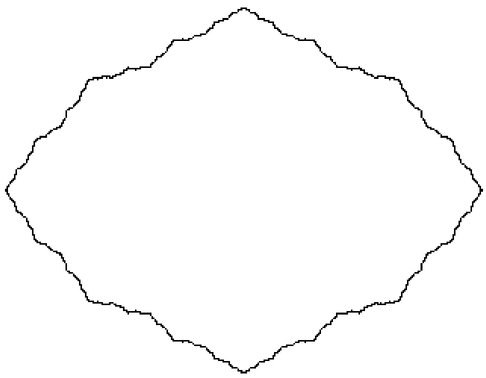

Fig. 1 Julia fractal for c = -0.3 - 0.05i

3. The Antenna Geometry

The Julia structure shown in Fig. 1 is embedded on FR4 epoxy substrate with permittivity of 4.4 and thickness 1mm and fed at the edge by a microstrip feed line whose width is 0.5mm. On the XY plane lays the ground. Substrate measurements are 20 x 20 x 1 mm^3. Fig 2 displays the Julia fractal antenna.

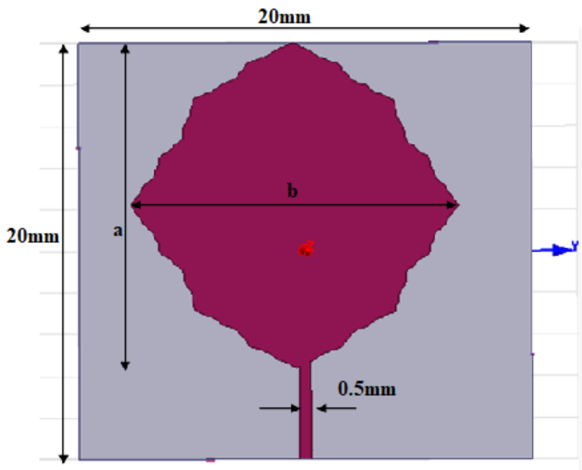

Fig. 2 The Julia fractal antenna

4. Results And Discussions

The performance parameters of the proposed Julia fractal antenna are analyzed using full wave EM simulator such as ANSYS HFSS. Fig. 3 shows reflection coefficient of the Julia fractal antenna for a=15mm and b = 14mm. We note that the antenna functions in three frequency bands with a 5.8 GHz, 9.3GHz and 17GHz centre-frequency. From Fig. 4, 5 and 6 it is seen that the antenna gain is more than 1.5dB for all the three bands.

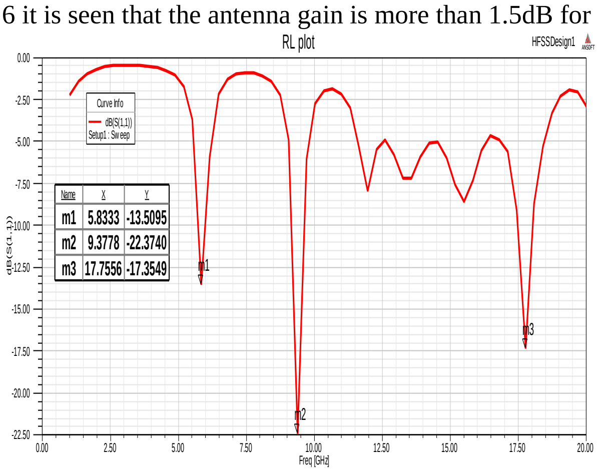

Fig. 3 Reflection coefficient of Julia fractal antenna

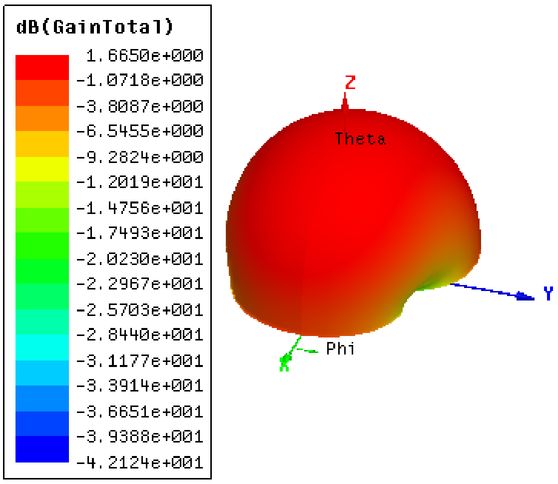

Fig. 4 gain at 5.8GHz

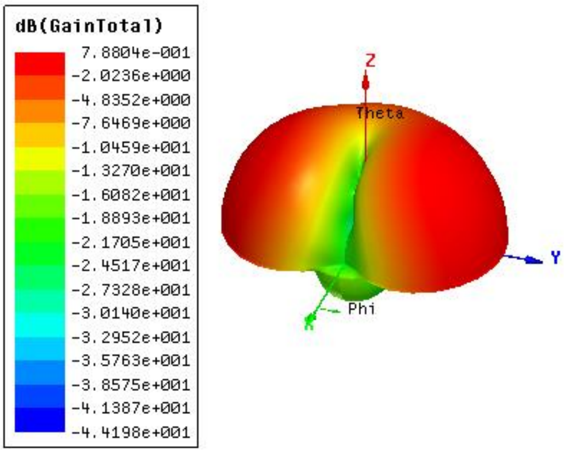

Fig. 5 gain at 9.3GHz

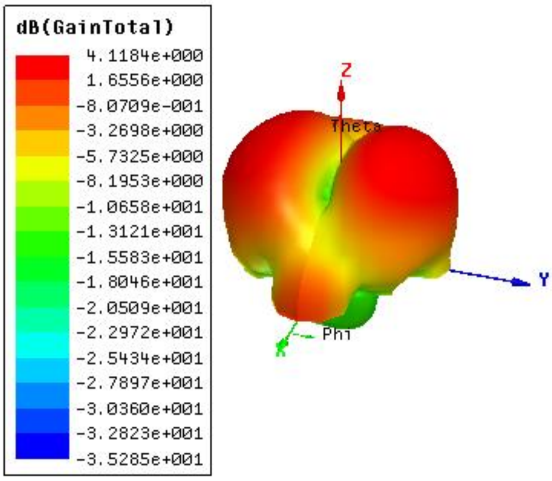

Fig. 6 gain at 17dB

By changing the values of 'a' and 'b' of the Julia fractal it is noticed to change the operating frequency of the antenna. It is observed that when the Julia fractal is perturbed in the vertical direction (i.e. by changing a) the operating frequency of the antenna changes. But when it is perturbed in the horizontal direction (i.e. b is changed) the return loss is decreased meaning good impedance matching is obtained. Summary of perturbation is shown in Table 1.

a	b	Band1 in GHZ	RL in dB	Band2 in	RL in	Band3 in	RL in dB

				GHZ	dB	GHZ	
12	14	6.8	-25	10	-13	18	-20
9	14	9.3	-23	18	-19	22	-15
12	16	6.8	-30	10	-22	18	-26
9	16	9.3	-29	18	-24	22	-29

5. Conclusion

Julia multiband fractal antenna is proposed in this paper. Three operating bands are observed in the frequency range of 5 to 20GHz. The antenna operating bands can be modified by providing sufficient perturbations to the Julia fractal. It is observed. In future the antennas can be manufactured and tested.

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