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Design and Analysis of Tripple Band Koch Fractal Yagi Uda Antenna

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ABSTRACT

The proposed antenna is Koch fractal printed Yagi-Uda antenna fed by SMA connector. The radiation characteristics of the antenna are simulated by CST Microwave Studio and analysed with the help of simulated results. The antenna's currents distribution becomes more uniform after being fractal, which is conducive to increase the antenna’s radiation directivity. The proposed Koch fractal Yagi-Uda antenna resonance at frequency of 7.81 GHz, 8.54 GHz and 9.42 GHz with gain of 9.67 dB, 10.4 dB and 10.61dB respectively. Parameter of antenna such as return loss, input impedance, smith chart, radiation pattern is analyzed for performance evaluation of Koch fractal Yagi-Uda antenna.

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1. INTRODUCTION

Yagi-Uda antenna is a kind of directional antenna with simple structure. The Yagi-Uda antennas have been used not only for home TV applications but also for modern wireless communications [1-3]. A conventional Yagi-Uda antenna consists of driven element and several parasitic elements (reflectors and directors), radiates end fire beams [4-6].The antenna's characteristic is being difficult to integrate with communication circuits and narrow bandwidths have limited its application scope with the rapid development of communications technology. Several researchers have put forward a series of printed Yagi-Uda antennas, which can be easier to integrate for communication circuits. This paper proposed a novel Koch fractal monopole Yagi-Uda antenna and the monopoles' ground plane acts as the ground plane of the antenna, which can help in lower the resonant frequency while the size in the polarization direction stays the same. The proposed antenna achieves the bandwidth of 86.2 MHz, 119.3 MHz and 483.9 MHz at the resonant frequency of 7.81 GHz, 8.54 GHz and 9.42 GHz respectively. Simulation of antenna design was carried out by Computer simulation technique (CST) MW studio software [7].

2. ANTENNA STRUCTURE

The design of proposed innovative Koch fractal Yagi-Uda antenna is shown in figure 1. The parameter used for designing the proposed antenna is defined in Table 1. The FR-4 lossy resin board with the relative permittivity 4.4 is used with length 180 mm, width 70 mm and height of 2 mm. On one side of resin board the antenna is printed and other side is ground plane. In the figure 1, the electric length of monopoles' refer to the length along the +*y* direction and the length of resin board is consider along the +x direction.

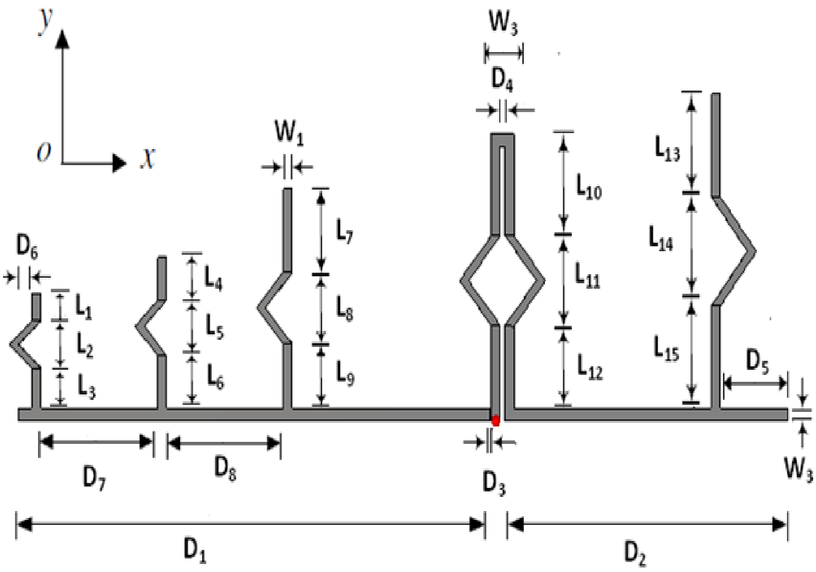

Figure 1. Sketch of Koch fractal yagi-uda antenna. L=length, D=width, W=thickness

By dividing equally a line segment into three parts and replacing the middle part with an isosceles triangle the Koch fractal curve is obtained [8]. In this paper a common case is that the isosceles triangle is an equilateral triangle, which forms the first-order Koch fractal, as shown in figure 1. By dividing the three divided parts as the same steps above, higher-order Koch fractal curve can be obtained. The curve theoretically can achieve an infinite length while the area surrounded by the curve stays the same. Therefore, this practice has recently been widely applied to achieve antenna miniaturization [9-10]. The antenna consists of one driven element, one reflector and three directors. The antenna is excited by the SMA connector. SMA connectors are coaxial RF connectors developed in the 1960s as a minimal connector interface for coaxial cable with a screw type coupling mechanism. The connector has a 50 Ω impedance. It is placed at the one end of the driven element and can be seen in red color in the figure 1.

Table 1. Parameters for the design of proposed antenna.

Parameter	Dimension (mm)	Parameter	Dimension (mm)
L_1	4.5	L_{14}	17.9
L_2	7.7	L_{15}	16.9
L_3	6.7	W_1	2
L_4	7.09	W_2	5.1
L_5	9.11	W_3	2
L_6	8.7	D_1	105
L_7	24.4	D_2	63
L_8	11.7	D_3	.3
L_9	10.7	D_4	1.1
L_{10}	14.7	D_5	15
L_{11}	14.7	D_6	3
L_{12}	13.7	D_7	26
L_{13}	17.9	D_8	26

3. SIMULATION RESULTS

The simulated result of the proposed antenna is shown in figure 2, indicating the graph of return loss verse frequency. The proposed antenna has return loss of -19.5 dB, - 24.6 dB and -50.8 dB at the resonant frequencies of 7.81 GHz, 8.54 GHz and 9.45 GHz respectively. The proposed Yagi-Uda antenna has achieved the bandwidth of 86.2 MHz, 119.3 MHz and 483.9 MHz at respective resonant frequency as shown in figure 2. Figure 3 shows the smith chart [11] of the proposed Koch fractal Yagi-Uda antenna, Impedance matching is analyzed by investigating the Smith chart of antenna which shows that the impedance of the antenna is matched with feed i.e. 50 Ω for 9.42 GHz.

Table 2. The simulated results of proposed Koch fractal Yagi-Uda antenna.

Resonant frequency (GHz)	Return loss (dB)	Bandwidth (MHz)	Gain (dB)	Directivity (dBi)
7.81	-19.5	86.2	9.67	10.66
8.54	-24.6	119.3	10.4	11.03
9.42	-50.8	483.9	10.6	11.30

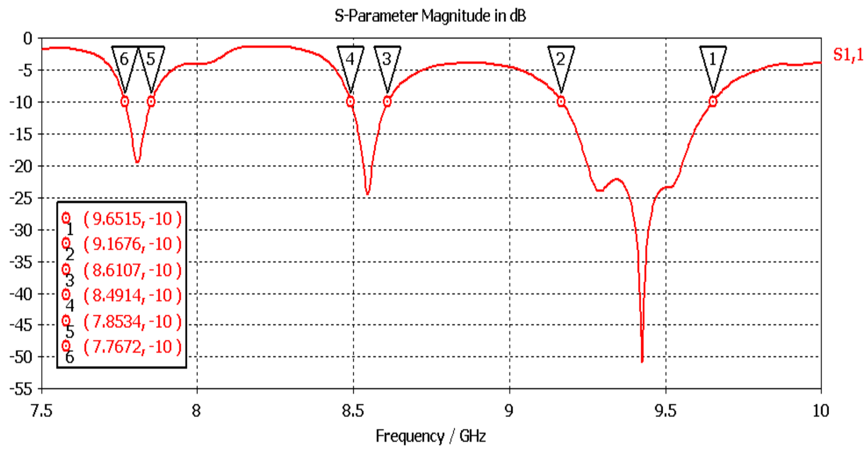

Figure 2. Return loss of proposed Koch fractal Yagi-Uda antenna.

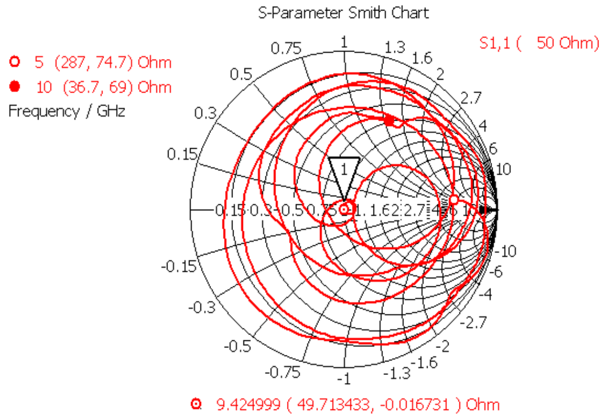

Figure 3. Smith Chart of proposed Koch fractal Yagi-Uda antenna at 9.42 GHz.

The radiation pattern of the proposed antenna is shown in figure 4, 5 and 6. The radiation pattern of figure 4 shows the directivity of 10.66 dBi at the resonant frequency 7.81 GHz, the radiation pattern of figure 5 shows the directivity equal to 11.03 dBi at the resonant frequency of 8.54 GHz and the radiation pattern of figure 6 shows the directivity is 11.30 dBi at the resonant frequency of 9.42 GHz. Table 2 is indicating the all results obtained at different resonant frequency.

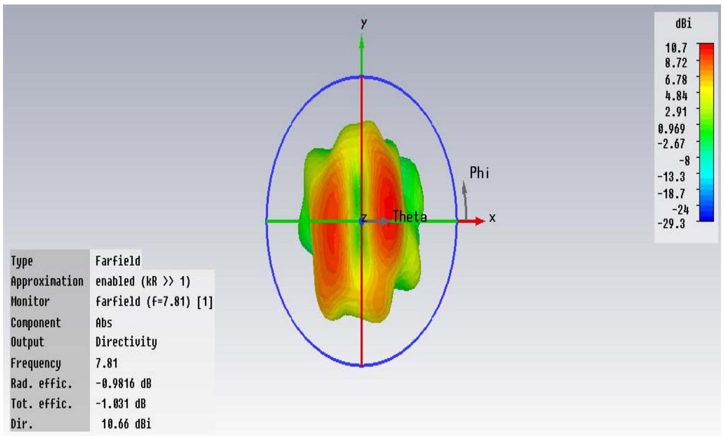

Figure 4. Radiation pattern of proposed Koch fractal Yagi-Uda antenna at 7.81 GHz.

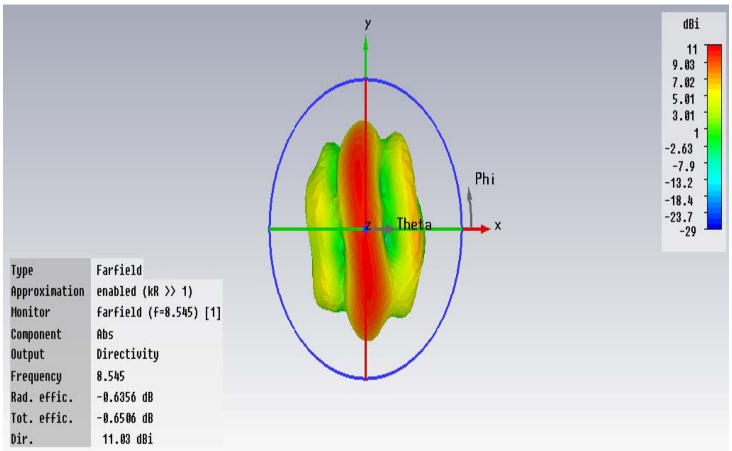

Figure 5. Radiation pattern of proposed Koch fractal Yagi-Uda antenna at 8.54GHz.

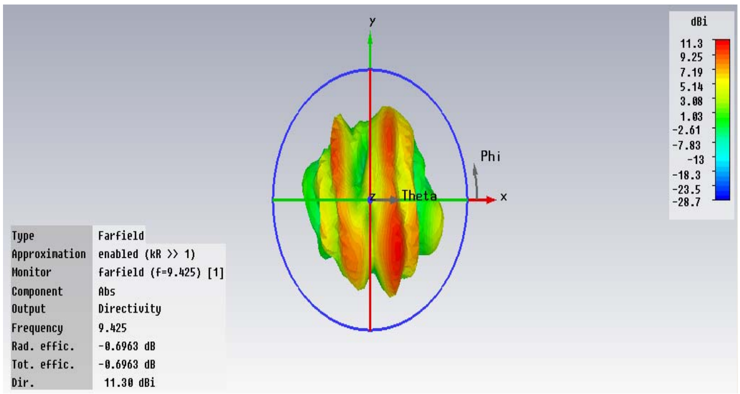

Figure 6. Radiation pattern of proposed Koch fractal Yagi-Uda antenna at 9.42 GHz.

4. CONCLUSION

A novel Koch fractal Yagi-Uda antenna is proposed with high gain, high directivity and high band width. The first-order Koch fractal monopoles are applied to obtain a more uniform current distribution on the director, folded active monopole and reflector, and which helps in increasing the antenna's directivity. The proposed antenna has significant reduction in the return loss and achieves the gain of 9.6 dB, 10.4 dB, 10.6 dB, directivity 10.66 dBi, 11.03 dBi, 11.30 dBi and bandwidth of 86.2 MHz, 119.3 MHz and 483.9 MHz. From above results it is observed that there is a significant improvement in Yagi-Uda antenna in C & X band.

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