Design of the Novel Koch Fractal Triangular Shape Iterated Antenna

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Abstract— In this paper, Koch star shaped fractal antenna is proposed for commercial applications. The antenna has been designed by using self-similarity property i.e. Boolean addition of triangular shape patches [1-3]. Designing of Koch snowflake for different resonant frequency by increasing number of iterations are given. The proposed wide-band antenna is designed to operate at personal communication system (PCS 1.85–1.99 GHz), universal mobile telecommunication system (UMTS 1.92–2.17 GHz), Bluetooth /wireless local area network (W-lan), which operate in the 2.4 GHz (2.4–2.484 GHz) bands, mobile worldwide inter-operability for microwave access (mobile WiMAX), and WiMAX, which operate in the 2.3-2.5 GHz. The proposed antenna is fed by a 50Ω microstrip rectangular feed line and fabricated on a low-cost FR-4 lossy substrate having dimensions 40(l) × 40(w) × 1.6(h) With =4.4. The antenna shows acceptable gain 2-3 in the antenna bandwidth with nearly radiation pattern Omni-directional in the frequency band for telecommunication system applications [4-8].

Key words: Koch Fractal, Wideband, Microstrip Feed

I. INTRODUCTION

The rapid expansion and transformation of wireless technology has drawn new demands for devices which can be operated at different frequency for different purposes i.e. the demand of integrated components including antennas. Antennas are considered to be the largest component of the integrated low profile wireless communication systems therefore, antennas miniaturization is necessary for achieving an optimal design. Numerous techniques have been proposed for the miniaturization of microstrip patch antennas with wide-band characteristics. Fractal structure is made in order to obtain a reduced size multiband antenna. This is mainly due to the self-similarity property of fractals which means that some of their parts have the same shape as a whole object but at different scales. In addition, due to their space filling properties, fractals are used in antenna miniaturization. The use of space filling curves increases the antennas electrical length. Therefore, the fractal geometry allows miniaturization of radiators with small overall dimensions. Thus, the miniaturization effect in fractal microstrip antenna is based on lengthening of the surface current lines in the patch element. As a result, the electrical length of the resonator is expanded and the entire structure can be miniaturized.

II. FRACTAL ANTENNA DESIGN

In the designing of star geometry in CST Microwave studio first take a cylinder of segment 3 it forms a triangle copy and rotate this triangle as shown in below figure.

Fig. 1: construction of a Koch snowflake for designing of proposed fractal antenna

There are three essential parameters for design of patch antenna i.e. Resonant frequency (fr), dielectric material of the substrate (ε_r), and the thickness of substrate (h). The dielectric material of the substrate selected for this design is FR-4 lossy which has a dielectric constant (ε_r) of 4.4. The resonant frequency of proposed antenna is given by

$$fr = \frac{2c}{3w\sqrt{\varepsilon_r}}$$

Where c = speed of light
ε_r = relative permittivity of substrate
Then patch side length w is given by

$$w = \frac{2c}{3fr\sqrt{\varepsilon_r}}$$

$$\lambda = \frac{c}{f}$$

Where ε_r =4.4
Ground length = λ/2

In order to improve bandwidth air gap is introduced means suspended technique is used. The configuration yielded improved measured bandwidth (1.8GHz–2.56GHz).

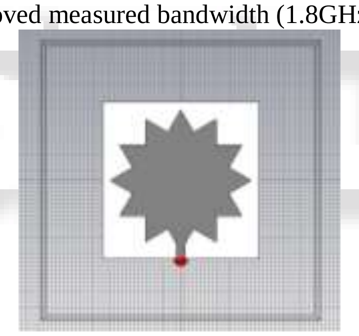

Fig. 2: Top view of the proposed snowflake Antenna

III. RESULTS AND DISCUSSION

The proposed snowflake antenna was simulated using CST Microwave studio software. The iteration steps and the results of these steps and the parameters i.e. the gain, return loss, VSWR and radiation pattern of the proposed fractal antenna is discussed below.

A. Design and Simulated Result for Basic triangular antenna

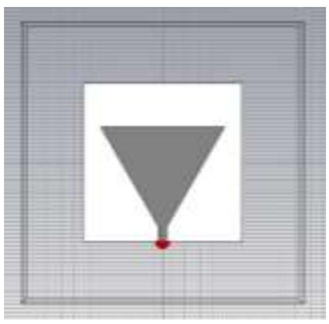

Fig. 3(a): front view of Basic triangular antenna

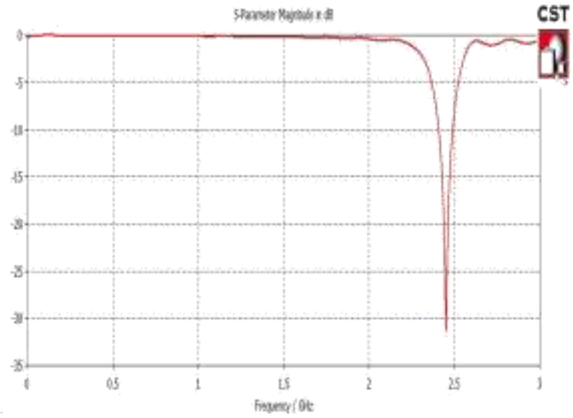

Fig. 3(b): Return Loss of the Basic triangular antenna

B. Design and Simulated Result for Iteration 1

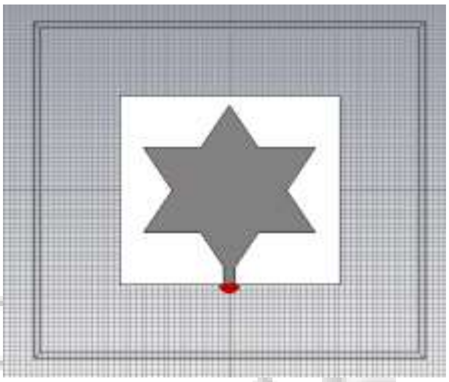

Fig. 4(a): front view of the first iteration of proposed antenna

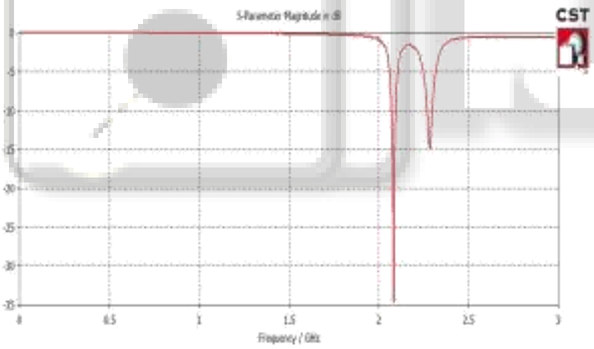

Fig. 4(b) graph shows the Return Loss of the proposed antenna it works at 2.1 GHz and 2.25GHz

C. Design and Simulation Result for Iteration 2

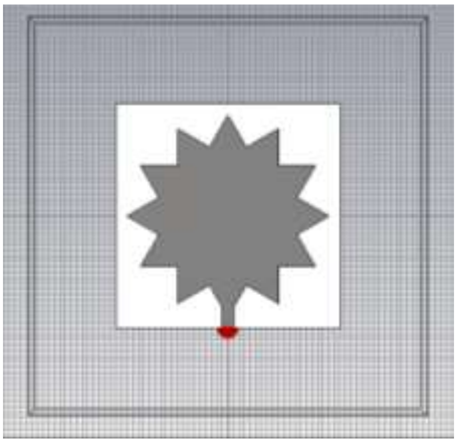

Fig. 5 (a) front view design of 2nd Iteration of the proposed antenna

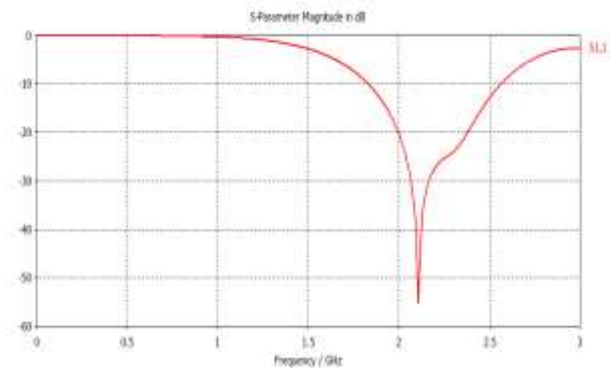

Fig. 5 (b) Return Loss plot of the proposed antenna shows the bandwidth of antenna 760MHz (1.8-2.483GHz)

IV. GAIN AND RADIATION PATTERN

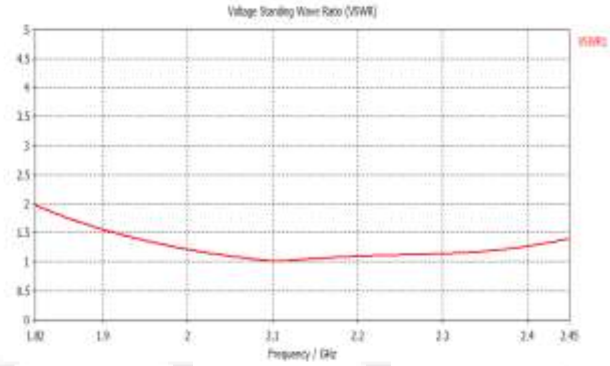

Fig. 6 VSWR plot of the proposed Antenna

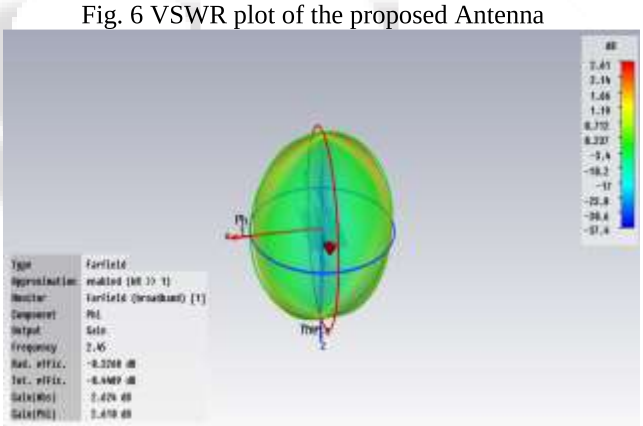

Fig. 7 Radiation patterns of the proposed antenna at 2.45GHz

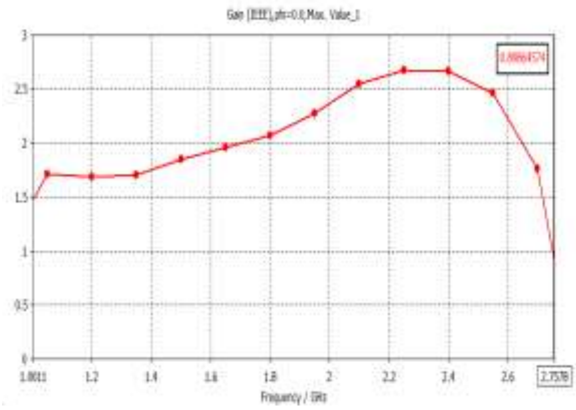

Fig. 8 Gain of the proposed Antenna

Gain of the proposed antenna 1GHz to 2.7GHz which is considerable good and it is maximum at 2.3 GHz

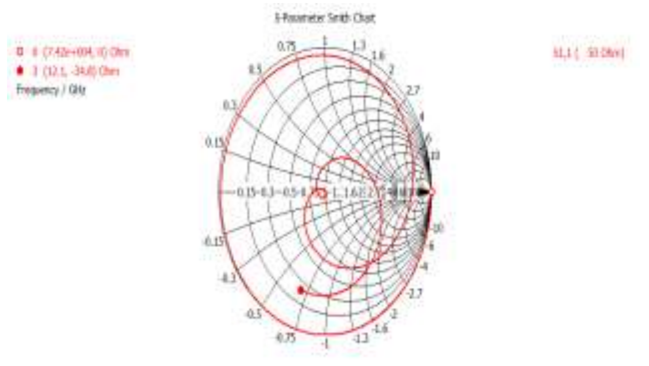

Fig. 9 smith chart of proposed Koch fractal antenna

V. CONCLUSION

It is observed that as the resonant frequencies decreased after each iteration gain is increased. The iteration is increased by introducing number of triangle and length of one antenna reduced by bending the 2/3 pattern of the koch fractal antenna counter clockwise. Then again rotating whole antenna 90° counter clockwise with specific dimension improves the antenna gain as well as its bandwidth. The proposed antenna have some favorable characteristics such as compact size, almost symmetrical radiation pattern , higher gain, satisfactory return loss less than 10 dB and acceptable bandwidth in desired frequency (1.8-2.483GHz) ISM(industrial scientific medical) band. Due to increase number of iteration configuration we get wide-band frequency bandwidth 760MHz. The proposed antenna is capable of covering the W-lan/WiMAX communication standard (2.4-2.484GHz)

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