Improved Multiband Triangular Fractal Patch Antenna for Wireless Communication

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Abstract- The purpose of this paper is twofold firstly we have attempted to design a fractal patch antenna for multiband operations. The operating frequencies obtained are at 4.49 GHz. And multiband frequencies are 3.9 GHz, 8 GHz, and 3.8 GHz. 6 GHz, 7.5GHz 11.75 GHz, 14.75 GHz, and 18.75 GHz the simulated result shows that the operating frequencies obtained are spread over a wide range of frequency band compared to the simple fractal patch antenna. Secondly this paper tries to evaluate the sustainability and life cycle management of proposed antenna. It uses the HFSS for simulation. It is observed that there is an improvement in return losses and VSWR when the iteration is increased and a layer is formed over the antenna. The paper observes that when there is an increase in iteration then the antenna bandwidth increases. Further it is noticed that the gain of antenna increases after layer. We see when we do fractal then the gain of the antenna degraded but this paper noticed that the gain of the antenna increases after fractal. The paper uses the substrate material duroid(tm) with relative permittivity 2.2. The result of the analysis shows that improved form of antenna is very useful in the cellular communication.

Keywords – Antennas, iteration, multiband operation, gain, return loss

I. INTRODUCTION

The antenna with wider bandwidth and smaller dimension are the requirement of modern telecommunication system. In present scenario there is a fall in the size of electronics system and a miraculous increase in the functionality. However, the antennas have not been changed so far. The wavelength of the antenna, also considered as the distinguished characteristics seems to have influence on the radiation characteristics. But research shows that with the reduction of antenna size there is a change in the bandwidth, gain and efficiency of antenna [1]. The immense progress of wireless industry has sparked at interest in multiband antenna. The most interesting example of a recent multiband antenna development is the incorporation of fractal geometry in to radiator and the Sierpinski gasket antenna. Various other multiband antennas can also be constructed by using fractal geometry. For our analysis in this paper, we are using a triangular shape configuration. A triangular shape fractal patch antenna is separated by a dielectric substrate. However for maximum radiation, low dielectric substrate is preferred. A triangular shape fractal antenna is characterized by it's length, width, i/p impedance gain and radiation pattern. Microstrip triangular patch find various application in design of many useful MIC component such as resonator, circulator and filter [7]. In the present paper, attempts to design triangular shape fractal antenna of compact size with good radiation and good multiband characteristics. The multi band and ultra wide band properties of antenna are due to their self-similarity of fractal geometry [2]-[3] while the space filling properties [4]-[5] of antenna leads to the miniaturization of antenna. To the growing demand of MMIC compatible antennas, patch antennas are good solution. In this work, Sierpinski Gasket fractal geometry has been applied to an equilateral triangular fractal patch antenna to reduce its overall size. It is found that as the iteration number increases, the resonant frequency become lower than those of the zero iteration, which represent a conventional equilateral triangle patch.

II. DESIGN SPECIFICATION FOR PROPOSED ANTENNA

The paper observes many parameters using Anasoft HFSS software. The configuration of proposed antenna of stacked resonator structure is shown in fig. First and second resonator is equilateral triangles modified with 2nd iteration Sierpinski Gasket fractal. It is a triangular shaped fractal patch antenna fabricated on duroid substrate with dielectric constant 2.2 and substrate thickness 1.588mm. The size of substrate is used 50mm by 50mm. To calculate resonant frequency of a simple equilateral triangular patch without any degree. Side length of equilateral triangle patch calculated from above equation. During simulation it was observed that if increases in fractal iteration count then the side length of both patch decreased for operation in same band. The area of lower triangle is 11.75mm and the area of upper patch is 62.35mm. Both patch are electromagnetic coupled. The width of feed line is set to achieve line impedance of 50ohm. Here we are using Microstrip feeding and the length of feed line is 23.13.mm. Both patches are grounded short. The upper substrate thickness is 10mil. Here we see after 2nd iteration, we are getting three band. In this proposed paper we see after fractal gain not degraded and the gain of the antenna increases.

$$f_{m,m,1} = \frac{2c}{3a(\epsilon_r)^{1/2}}(m^2 + mn + n^2)^{1/2}$$

$$a_{eff} = a + h(\epsilon_r)^{-1/2}$$

$$\epsilon_{eff} = \frac{1}{2}(\epsilon_r + 1) + \frac{1}{4}(\epsilon_r - 1)(1 + \frac{12h}{a})^{-1/2}$$

$$f_{m,n} = \frac{2c}{3a_{eff}}(\epsilon_{eff})^{\frac{1}{2}}(m^2 + mn + n^2)^{1/2}$$

where

a = length of equilateral triangular patch h = thickness of substrate

ε_r =relative dielectric constant

C = velocity of light

Tmn is the resonant fundamental mode hence

m = 0 & n = 1

The calculated side length of equilateral triangular patch from above equation was taken as starting value. For the first iteration, the paper takes one third area of the patch of antenna. In the second iteration, one third area of first iteration is used. This paper we are using three layer with different thickness.

III. KEY BENEFITS OF FRACTAL IN ANTENNA GEOMETRY

With increasing number of iterations of fractal resonant frequency increases which results in lower returns losses.
Compact size compared to the antennas having conventional designs, while maintaining good to excellent efficiencies and gains. Characteristics of fractal antennas are obtained due to its geometry and not by the addition of discrete components.
Ability to design for particular multi-frequency characteristics
Containing specified stop bands as well as multiple pass bands.

IV. RESULT

Three iteration results performed on the triangular patch to get the desired fractal antenna are as follow:

RESULT FOR ITERATION 0

When triangular fractal antenna structure having zero iteration has show in fig. On simulating this structure with the help of Anasoft HFSS, the following result were obtained

Fig. 1 (iteration 0)

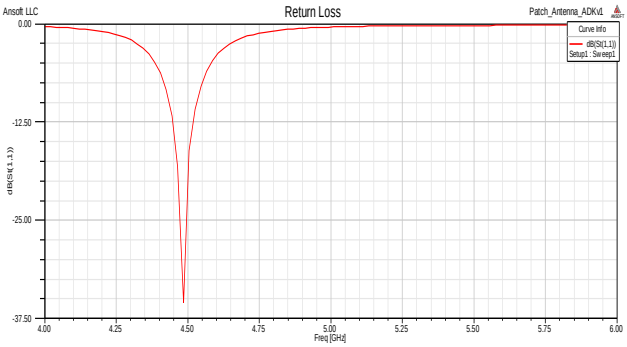

Fig. 2. (Return losses for various frequencies)

That is return loss is found to be -23.75 dB at 4.49 GHz frequency

RESULT FOR ITERATION 1

The structure of triangular fractal antenna with first iteration is as follows:

Fig. 3 (iteration 1)

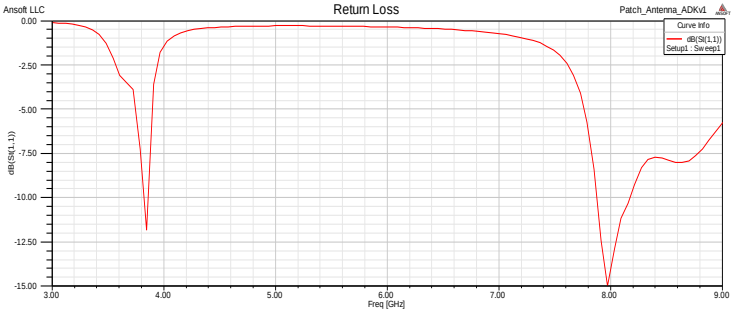

Fig. 4. (Return losses for various *frequencies)*

That is return loss is found to be -11.75 dB at 3.9 GHz frequency and -15 db at 8 Ghz frequency.

RESULT FOR ITERATION 02

The structure for triangular fractal antenna with 2nd iteration is:

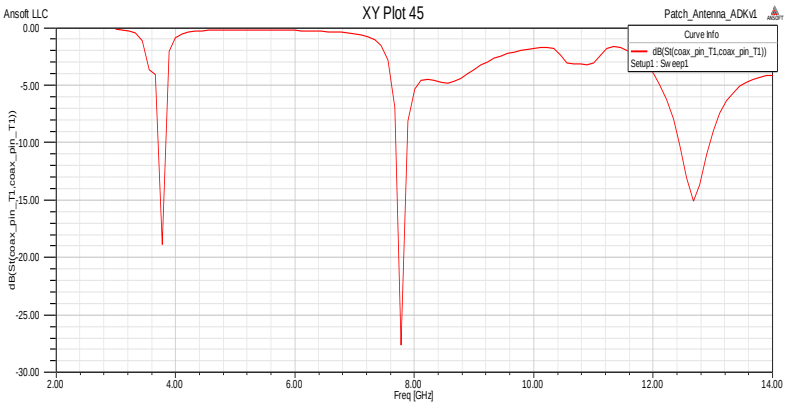

Fig. 5 (iteration 2)

Fig. 6 (Return losses for various *frequencies)*

That is return loss is found to be -19 dB at 3.8. GHz frequency and -27.5 dB at 7.8 GHz frequency and -15 dB at 6 GHz frequency.

RESULT FOR AFTER LAYER IN ITERATION 03

The structure for triangular fractal antenna with LAYER in 3rd iteration is:

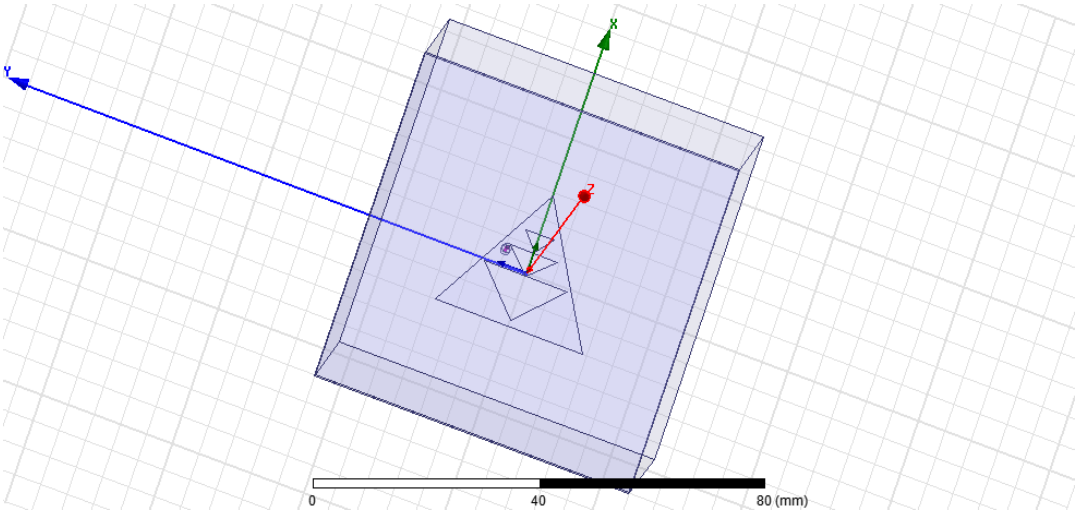

Fig. 7 (after layer)

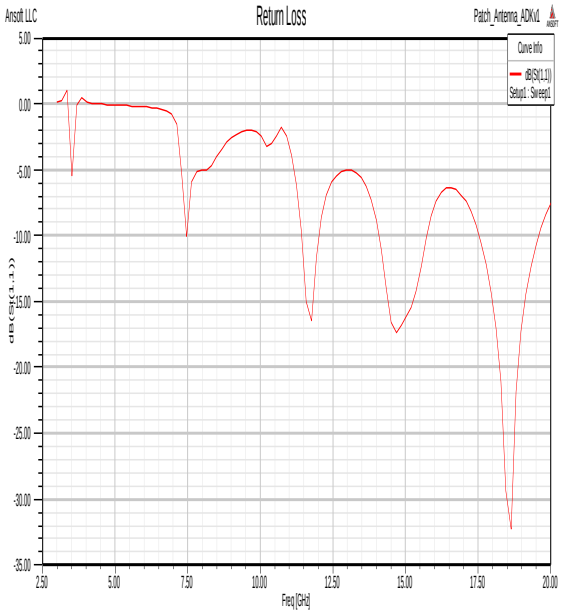

Fig. 7 (Return losses for various frequencies)

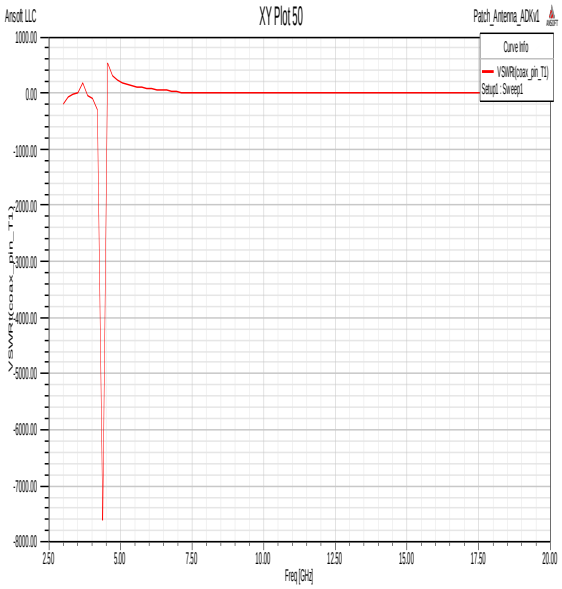

Fig. 8 (VSWR vs frequency)

That is return loss is found to be -10 dB at 7.5 GHz frequency and -16.dB at 1.75 Ghz Frequency and -17 dB at 14.75 GHz frequency and -32..dB at 18.75..GHz frequency.

V. CONCLUSION

Triangular shape fractal antenna up to second iteration hasbeen built & simulated using Anasoft HFSS. It is observed that after second iteration we are getting three band below -10db but after layer also getting three band with good performance and show the multiband behavior and get positive gain. Thus the result shows that this improved antenna can be highly beneficial in the field of wireless communication.

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