INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 3, Issue 6)
Available online at www.ijariit.com

The Multiband Patch Antenna with Square and Hexagonal Shape for Different Wireless Applications

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Abstract: Fractal geometry involves a recursive generating methodology those results in the figure with infinitely convoluted fine structures. They do not use additional loading components and are simple and cost-effective to fabricate. They can be mounted to constraining form factors, such as the casing of hand-held transceivers. In this paper, a fractal antenna is designed with Square and Hexagonal shape and operating between 4-7 GHz. The proposed antenna with the rectangular ground plane is modelled and simulated with Finite Element Method (FEM) based High Frequency Structure Simulator (HFSS) and an improvement in performance parameters (Return loss, Bandwidth (BW) and VSWR) is observed with change in design parameters. Fractal antennas prove worthwhile, high performance, resonant antennas for many practical applications. It is usually fabricated as or on small circuit boards, they allow new versatility in their use with wireless devices.

Keywords: Fractal, Patch Antenna, Bandwidth.

I. INTRODUCTION

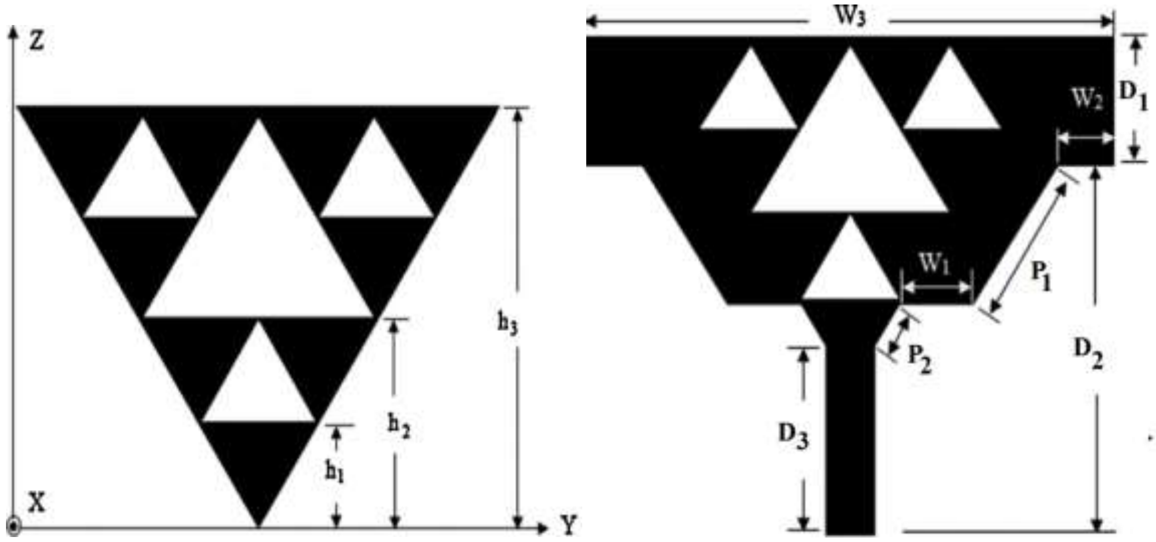
The term **FRACTAL,** that which mean wrecked or asymmetrical fragments. The development of the fractal geometry originally inspired from the pattern of nature. It is widely used in many streams of science and complex shapes found in nature such as trees, stars, and mountains etc [2]. There are several advantages of using fractal geometries in antenna design. First of all, it can reduce the size of the antenna, which makes it a good candidate for miniature antenna design. Basically, fractal geometries are self-filling structures that can be scaled without increasing the overall size [3]. Fractals can be used in two ways to enhance antenna designs. The first method is in the design of miniaturized antenna elements. These can lead to antenna elements which are more discrete for the end user. The second method is to use the self-similarity which provides flexibility in antenna by reducing the antenna size in horizontal and vertical direction. This would allow the operator to incorporate several aspects of their system into one antenna [4]. IFS also play an important role in the specification of fractal. Iterated mathematical process formed the shape of a fractal. So, the shape of a fractal is made up of overlapping smaller copies of itself, each copy is changed by IFS system. Such Fractal can be obtained by using computer graphics require particular mapping that is replicated over and over recursive algorithm. The best example is Sierpinski Gasket which is also known as Sierpinski triangle [5]. Benoit Mandelbrot described the term 'FRACTAL 'and he has described the relationship between fractal and nature using discovery made by Gaston Julia and Pierre Fatuous [6]. Its Latin name is fractus means 'broken': some of the parts have the same shape as the whole object but on a different scale [7]. This type of geometry became more popular in 1990. With the help of this geometry we can designed the multiband antennas as well as new dimension of antenna array. Fractal antenna has been become more popular because of its attractive features such as better input impedance matching, reduced mutual coupling in fractal array antenna, miniaturization and frequency independent [8]. Application of fractals to antenna design has proved to be a benefit to wireless communication system. Studies in this field proved that fractals result in high bandwidth, good gain and improved radiation pattern as compared to traditional antennas [9]. Fractal antenna has different structures like sierpinski gasket, sierpinski carpet, minikowski fractal antenna, and fractal tree antennas etc. If we conclude that certain electrical properties of an antenna are directly a function of certain physical properties of the antenna, then we must also conclude that significantly modifying these physical properties must significantly modify the antenna's electrical

properties. Alternately, if we significantly modify an antenna's physical properties and its electrical properties do not significantly change, then we must conclude that these electrical properties are not primarily determined by these physical properties [10-12].
In 1995, the first antenna element was designed by distorting the wire in an organized way, using the Koch fractal geometry, using the concept of fractals [13-15].
In 1998, Xu designed fractal based tree which could give satisfactory accomplishment as compared to previously designed Sierpinski gasket. Hohfeld submitted that the scaling factor consequents the attitude of frequency bands in frequency spectrum [16, 17].

In the following work, antenna parameters are regulating to explore the effect on bandwidth coverage and bandwidth gain intensification. The aim of present work is to design square and hexagonal fractal patch antenna and examine resonant frequency.

Earlier this sierpinski fractal is designed with single frequency band with single iteration and it was not able to cover the large area.

To improve this deficiency multiband frequency with single iteration and with square and hexagonal shape has been used.



(a) (b)

Fig. 1: Layout of Triangular Fractal (a) with basic structure (b) with patch fractal antenna [13]

II.SQUARE and HEXAGONAL FRACTAL

The Square and Hexagonal antenna has been designed and simulated on Rogers RT/duriod 5880 substrates, with dimensions of 30 x 28 x 2.58 mm^3, having relative permittivity 4.4 and tangent loss 0.02. The ground taken is semi-elliptical, having length 11.1mm and width 30mm and used lumped port as feed to achieve 50Ω characteristic impedance. The square fractal antenna has been simulated using Finite Element Method based Ansoft HFSS version 13 which divides the problem domain into a number of sub-domains and each sub-domain is represented by a set of element equations. For the final calculation, Systematic recombination of all sets of element equations is converted into a global system of equations.

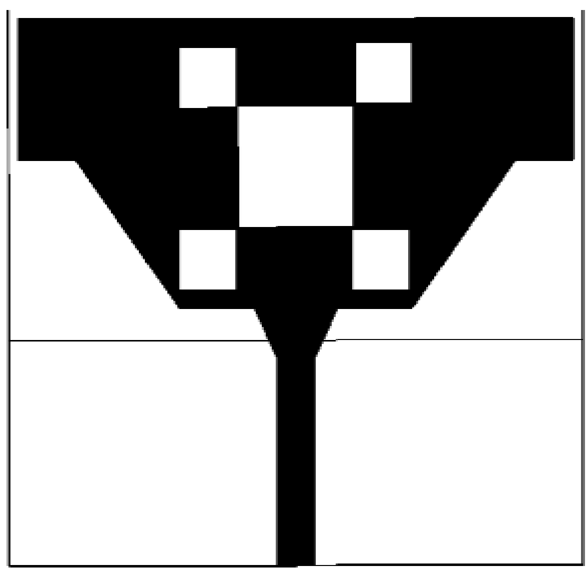


Fig.2: A Fractal Patch Antenna with Symmetrical Square Shape

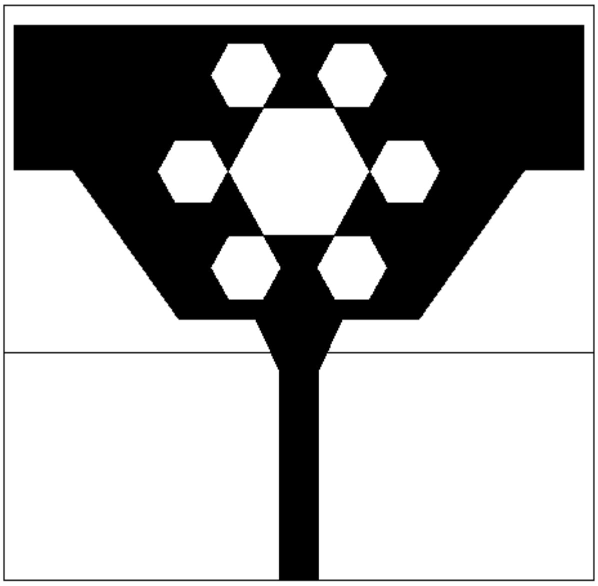


Fig 3.A Fractal Patch Antenna with Symmetrical Hexagonal Shape

III.RESULTS & DISCUSSIONS

Square Fractal antenna is simulated inside a waveguide to attain the resonating frequency region. The Perfect Electric Conductor (PEC) boundary conditions are used on the z-faces of the unit cell. The Perfect Magnetic Conductor (PMC) boundary conditions are used on y-faces of the unit cell to exit the negative permeability behavior of antenna. The proposed structure is simulated with Ansoft software 'High Frequency Structure Simulator (HFSS)'. The reflection coefficient and VSWR of Fractal antenna with a square shape are shown in fig. 4 and fig5.

By using square shape the two frequencies are occurred (5.63GHZand 7.03GHZ) with minimum return loss.

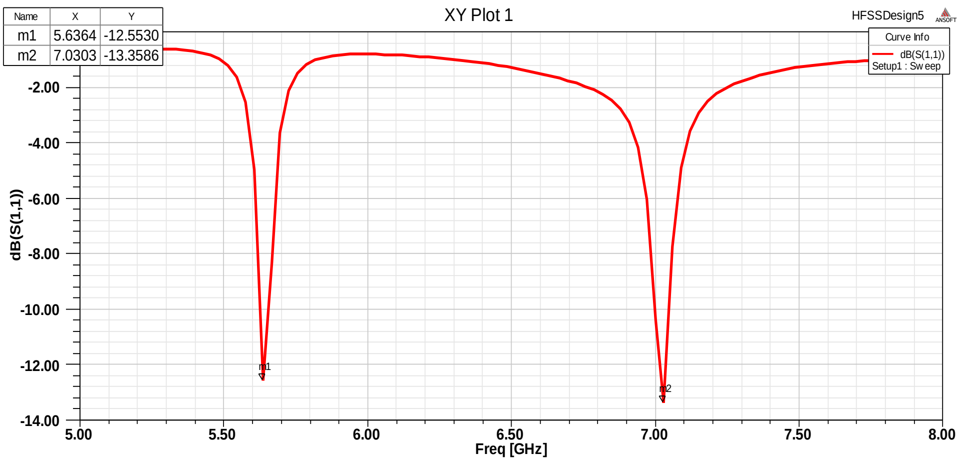


Fig.4: Reflection coefficient S_{11} of proposed Fractal antenna with square shape

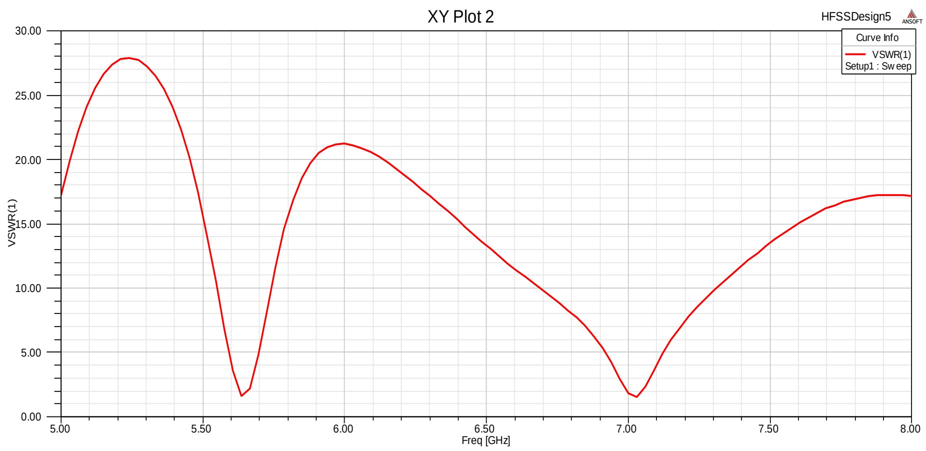


Fig. 5: VSWR of Proposed Fractal Antenna with Square Shape

The reflection coefficient and VSWR of Fractal antenna with hexagonal shape are shown in fig.6 and fig 7. It is observed from the reflection coefficient that with the hexagonal shape the fractal antenna gives a better result and with a single iteration, two resonant frequencies occur (5.63 GHz and 7.12 GHz) and the return loss of two are very good.

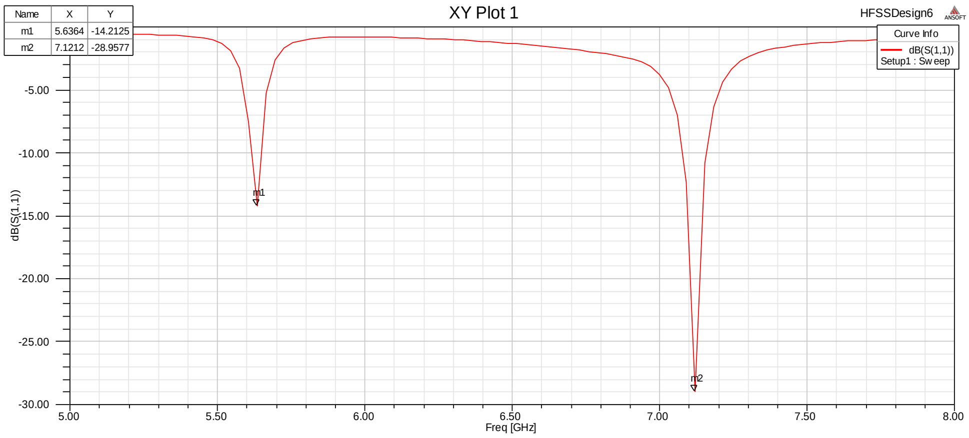


Fig. 6 Reflection coefficient S_{11} of proposed Fractal Antenna with Hexagonal Shape

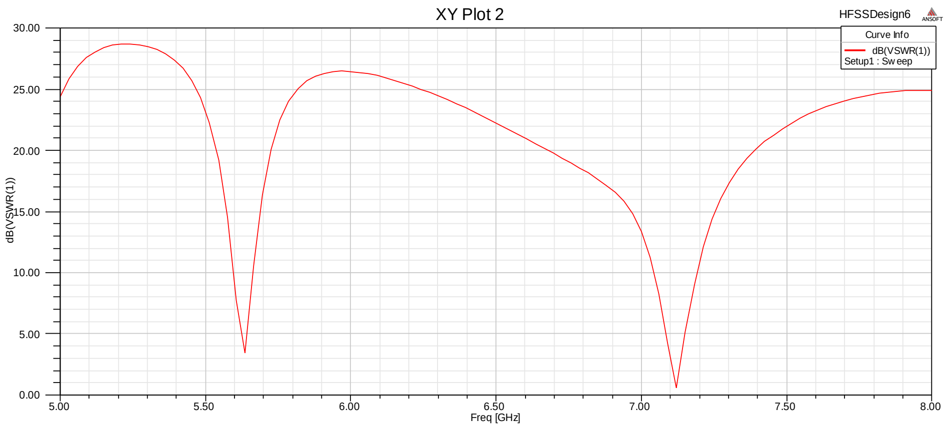


Fig. 7: VSWR of the proposed Fractal antenna with Hexagonal Shape

IV.CONCLUSION

This paper presented a comparison of the multiband behavior of the fractal antenna with two modified shapes (Square and Hexagonal) where major portions of the Sierpinski gasket's self-similar fractal gap structure were altered or eliminated completely. It was demonstrated that significant portions of the self-similar gap structure could be removed from the Sierpinski gasket without adversely affecting its multiband behavior. The Square and Hexagonal Fractal antenna is presented and simulated better return loss, suitable bandwidth (4-7) GHz and good impedance matching. It has been shown in the work that by optimizing design parameters of the antenna, improvement in the performance parameters, like return loss, VSWR, bandwidth and impedance matching, can be attained. The proposed TF antenna is suitable for use in Wi-Fi, terrestrial data links and WLAN etc.

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