Enhancing Multiband Fractal Antenna Design through Green Anaconda Optimization (GAO)

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Abstract: Fractals can be applied to antenna elements to create smaller, resonant, multiband/broadband antennas that can potentially be gain-optimized. They are easy and affordable to construct, and they don't require extra loading components. They can be affixed to restrictive form factors, such as the case of hand-held transceivers. For many real-world uses, fractal antennas prove to be valuable, high-performing, resonant antennas. They enable greater adaptability in their use with wireless devices and are typically built as or on tiny circuit boards. A new outline Multiband Printed Circular Fractal antenna is proposed in this paper. This roundabout fix receiving device is capable of operating at 10.3GHz, 16.7GHz, and 21.7GHz frequencies. It is employed because the fractal design system fills space and is self-comparable. The purpose of the roundabout fix antenna is to minimize the projected radio cable's area. The dielectric of the measurement substrate, the Rogers RT Duroid5880, is 2.2. The HFSS.15 programming software is used to calculate the proposed radio wire's radiation pattern, gain, return loss, and VSWR. The ultimate goal of Green Anaconda Optimization (GAO), which mimics the behavior of green anacondas, is to develop this suggested Multiband Fractal Antenna by increasing its efficiency, dependability, and range.

Keywords*: Fractal Antenna, Circular Patch Antenna, Multiband Frequencies, Rogers RT Duroid5880 Substrate, Green Anaconda Optimization (GAO).*

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I. INTRODUCTION

Fractal antennas, which have been developed over the past 20 years, are the only significant advancement in antenna technology in the past 50 years. Radiative element shaped using fractal geometry is called a "fractal element antenna". Benoit Mandelbrot and numerous others have worked to define and popularize the class of geometry known as fractal geometry. All of the current antenna types—dipole, monopole, patch, conformal, biconical, discone, spiral, helical, and others—can be made into fractal versions, and fractal technology allows us to create compact versions of each. Fractals' intrinsic properties allow for the creation of high-performance antennas that are usually 50–75% smaller than conventional ones. In addition to lower size, typical benefits include enhanced bandwidth/multiband and gain. Additionally, because antenna performance is achieved through the conductor's geometry rather than the accumulation of individual components or elements, which invariably increases complexity, potential points of failure, and cost, fractal antennas are more dependable and less expensive than traditional antennas. The end product is a single fractal antenna that can take the place of numerous conventional antennas.

Wideband and multiband radio cables are appealing for various remote applications; little satellite correspondence terminals, and individual correspondence frameworks. A radio cable must also be inserted into the airframe structure for some of these uses. It is customary to use strongly stacked wire radio wires to achieve a wideband receiving antenna in low recurrence remote groups. This typically means that different reception apparatuses are needed for different recurrence groups. Some intriguing solutions for using a single small reception device operating in a few recurrence groups are suggested by recent developments in the study of fractal radio wires. The self-similar characteristics of certain fractals cause radio antennas to conduct in several bands, and the extremely complex state of these fractals allows for the reduction in size, and consequently in mass and volume, of certain reception devices as studied.

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Fig 1 Fractal Antenna over Solar Cells

II. LITERATURE SURVEY

Mohamed Tarbouch al in [1], have talked about combining the two shrinking methods to achieve a high degree of microstrip patch antenna miniaturization. The first method involves cutting the ground plane that is positioned on the opposite side of the patch. The second method involves testing the H-Tree fractal slots in the ground plane that is produced.

Manas Ranjan Jena al in [2], have talked about a hybrid fractal slot (Koch-Koch) Microstrip Patch Antenna (MPA) design for wideband applications. Various fractal shapes are employed to achieve the requisite multiband characteristics and downsizing. It is possible to create fractal slots in a microstrip patch to overcome its constraints. The many fractal slot geometries that improve its utilization for various applications were examined in this paper.

Mahmood F. Mosleh al in [3], have talked about a microstrip patch antenna design that uses two methods, such as partial ground plane and fractal geometry, to boost the antenna's bandwidth while decreasing its size. This design makes use of the self-similarity property of fractal geometry and employs an iterative approach to fractal geometry up to the second iteration.

Rajitha Datla al in [4], have talked about creating an Ultra Wideband Monopole antenna for various WLAN and WIMAX uses. Iterative patch structures are taken into consideration to get the optimum result. Use different substrates to get the best results. Sierpinski Carpet Geometry is used in the design of the patch structure.

Penki Rohit al in [5], has discussed a low profile Sierpinski fractal antenna for wide band applications. The need for wideband, multiband, reasonably priced, and small antennas has increased during the last ten years due to advancements in communication technologies. Fractal antenna designs can be used to meet these requirements. Fractal forms are used in patch antennas nowadays to achieve enormous bandwidth and other advantageous characteristics.

III. GREEN ANACONDA OPTIMIZATION (GAO)

Green anacondas make up the population of the population-based metaheuristic algorithm known as Green Anaconda Optimization (GAO). From a mathematical perspective, each green anaconda is a potential solution to the issue, and the values of the decision variables depend on where it is located in the search space. The process by which the male species determines the location of the female during mating season and the green anacondas' hunting method serve as the primary sources of inspiration for Green Anaconda Optimization. These two methods of green anacondas in two periods of exploration and exploitation are simulated to present Green Anaconda Optimization (GAO) mathematical modeling. The design of GAO was inspired by the way green anacondas behave in the wild. The tracking system used by green anacondas during mating season and their hunting tactics while attacking prey serve as the primary sources of inspiration for GAO. The pursuit of female species by male species during the mating season and their hunting method are two of the most important natural activities of green anacondas. The suggested Green Anaconda Optimization technique is designed using mathematical modeling of these cognitive processes that are the natural behaviors of green anacondas.

IV. PROPOSED ANTENNA DESIGN

Self-similar structures are produced by iteratively designing the proposed fractal geometry on a circular patch. A visual representation of this iterative generating process may be found in Figure 2 (a), (b), (c), and (d). The patch is shown by the pink area in the picture, while the substrate is represented by the grey area. The ground plane's dimensions match those of the substrate, and the fractal antenna's geometry is designed on a 1.92x1.92 cm2 substrate. The Rogers RT Duroid 5880 substrate, which has a thickness (h) of 0.1588 cm, a loss tangent of 0.0009, and a relative permittivity of 2.2, is utilized in this design. A Sub Miniature version A (SMA) connector of 50Ω is connected at the end of the antenna feed line for input RF signal since the proposed antenna uses a microstrip line feed as its feeding technique.

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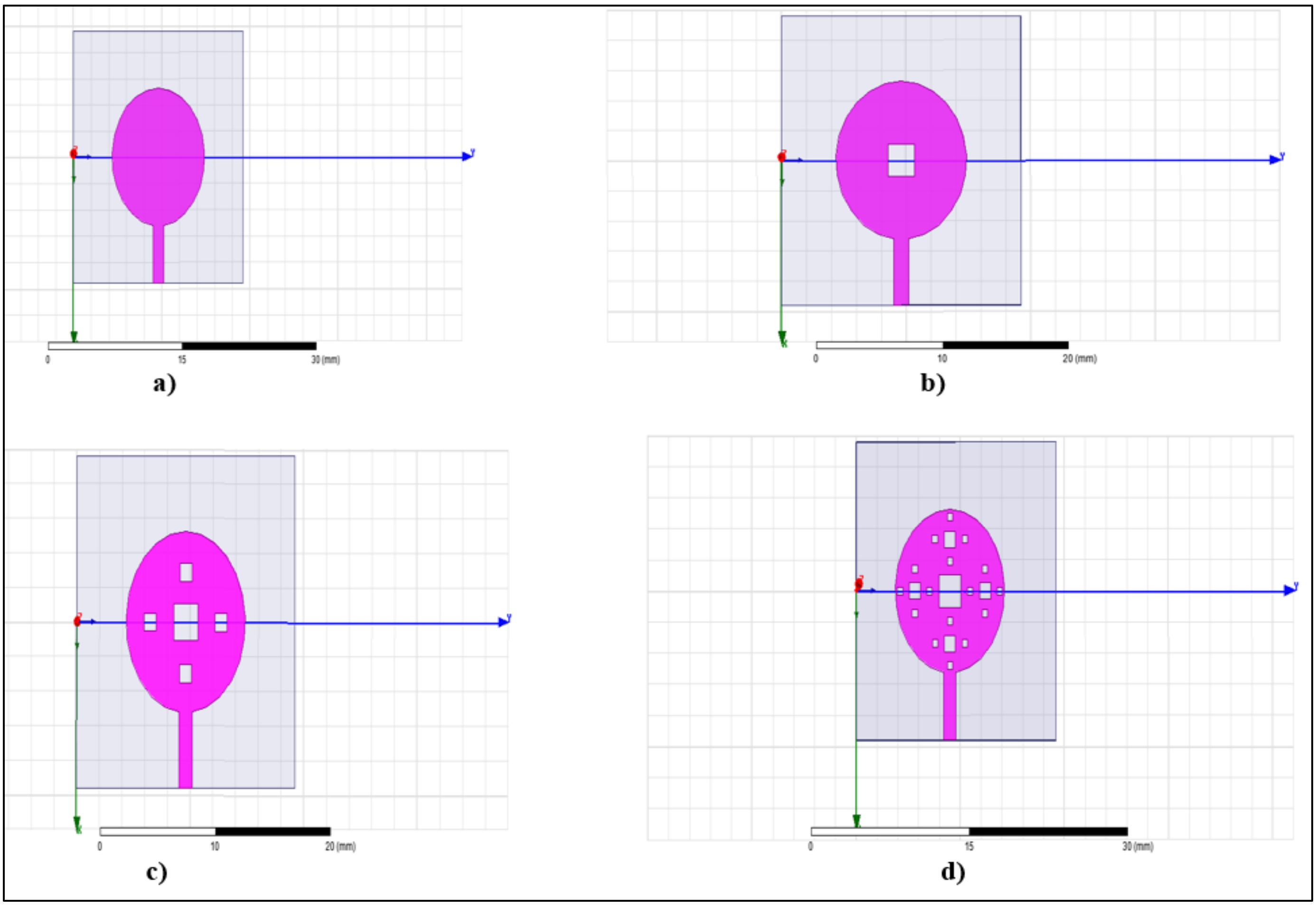

Fig 2 Geometry of Fractal Antenna a) 0th Iteration b) 1st Iteration c) 2nd Iteration d) 3rd Iteration

The radius of the circular patch is determined to be 0.525 cm using the transmission line formulae mentioned above. Figure 2. (b) illustrates how the rectangular slot is created to be center symmetric. The diameter of the circle is divided by five to determine the width and length of the rectangular slot in fig. 2(b). By dividing the circle's radius by five and then doubling the result for correct alignment, the center point of the other four rectangular slots in Figure 2(c) is determined. These four slots in Figure 2(c) are half as long and half as wide as the rectangular hole in Figure 2(b). Likewise, the smaller rectangular openings in Figure 2(d) are half as long and half as wide as the rectangular slot in Figure 2(c). The geometry of the suggested fractal antenna produced following the third iteration is shown in Figure 3.

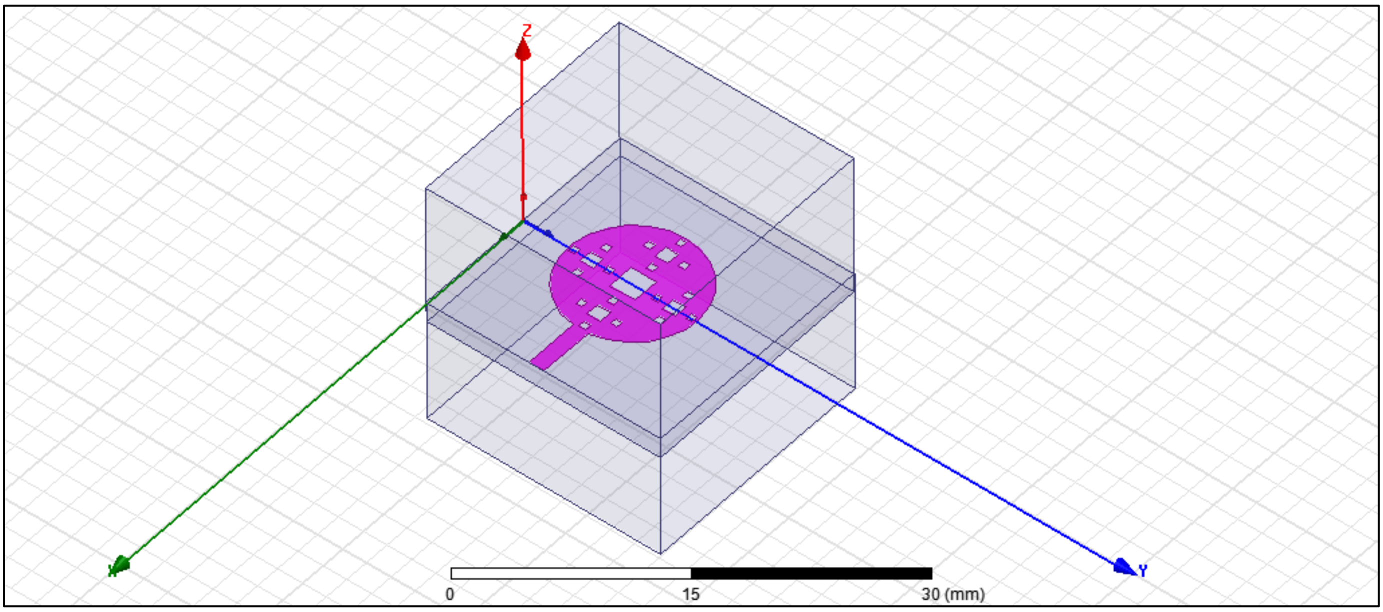

Fig 3 Design of Novel Circular Fractal Antenna Design using HFSS

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V. SIMULATION RESULTS

➢ *Return Loss*

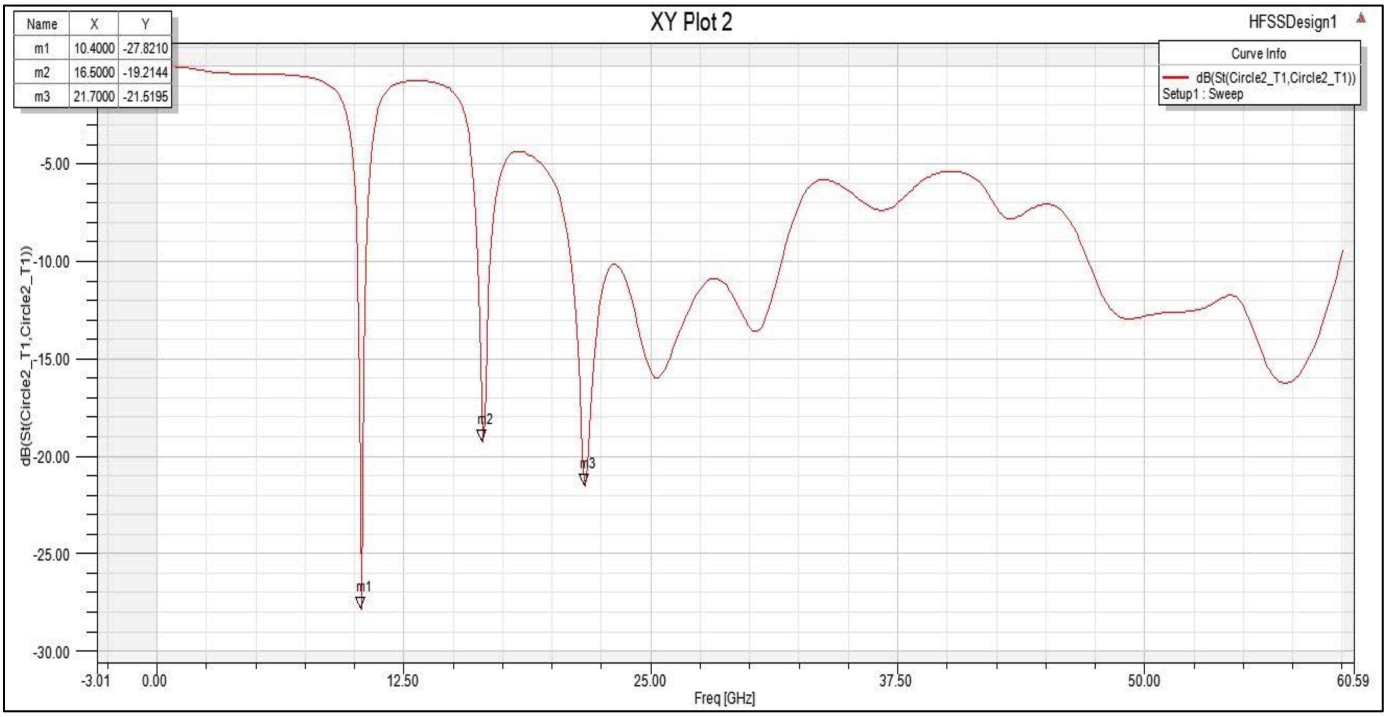

Fig 4 Return Loss of Circular Patch Fractal Antenna

Figure 4 corresponds to the Return Loss for the Circular Patch Fractal Antenna in Figure 3.The reported return loss for this antenna is -21.51 at 21.7 GHz, -19.21 dB at 16.5 GHz, and -27.82 dB at 10.4 GHz.

➢ *VSWR*

Unity is the lowest VSWR that denotes a perfect match. Figure 5 displays the Circular Patch Fractal Antenna's VSWR, which corresponds to Figure 3. The range of an antenna's VSWR is 1 to infinity. When it comes to real-world applications, it should be between 1 and 2. At 16.5 GHz, the VSWR is found to be 1.4

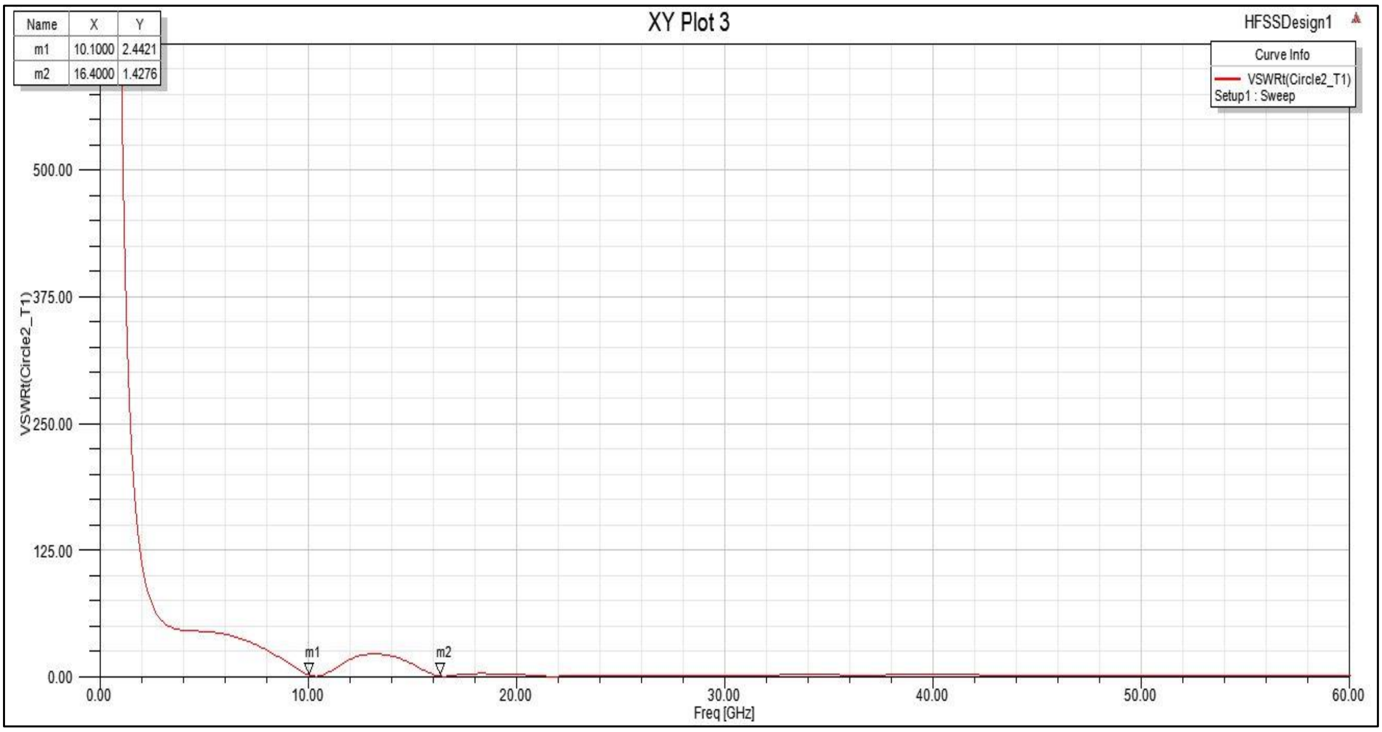

Fig 5 VSWR of Circular Patch Fractal Antenna

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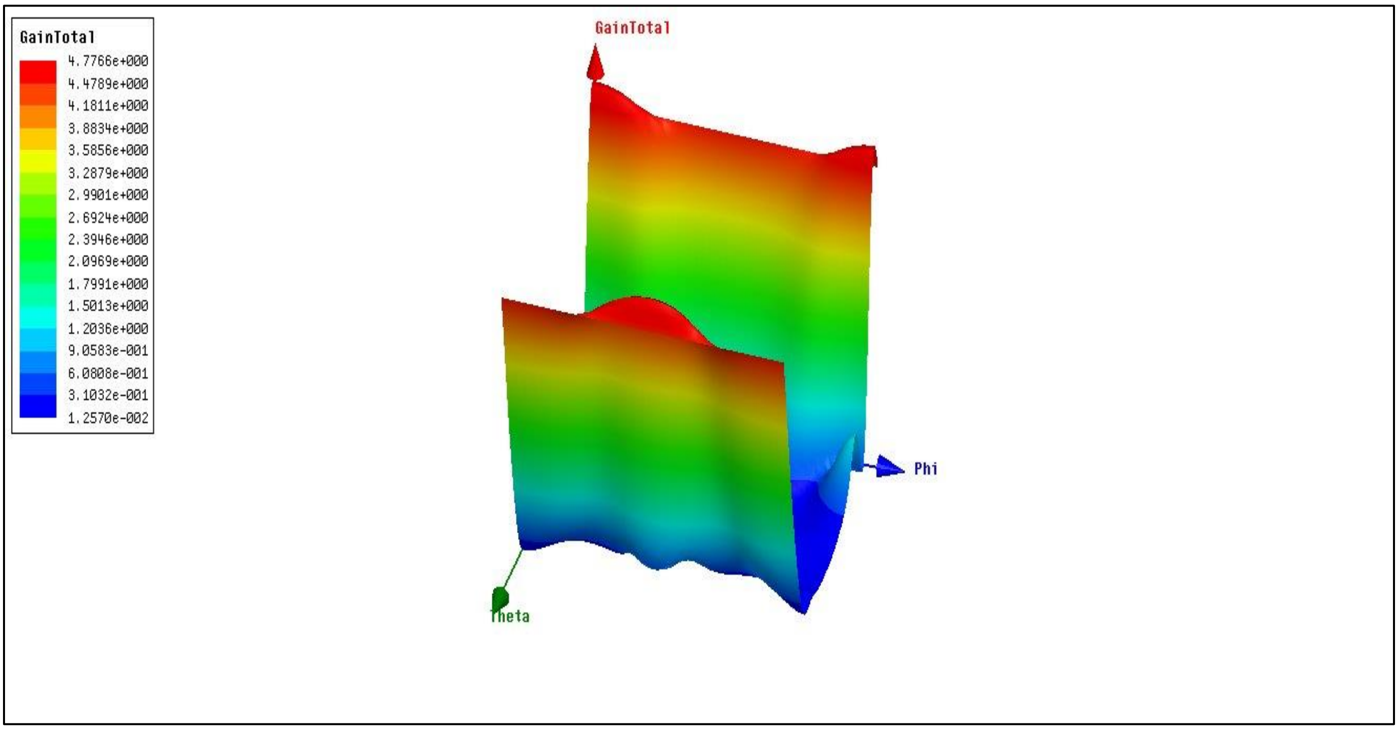
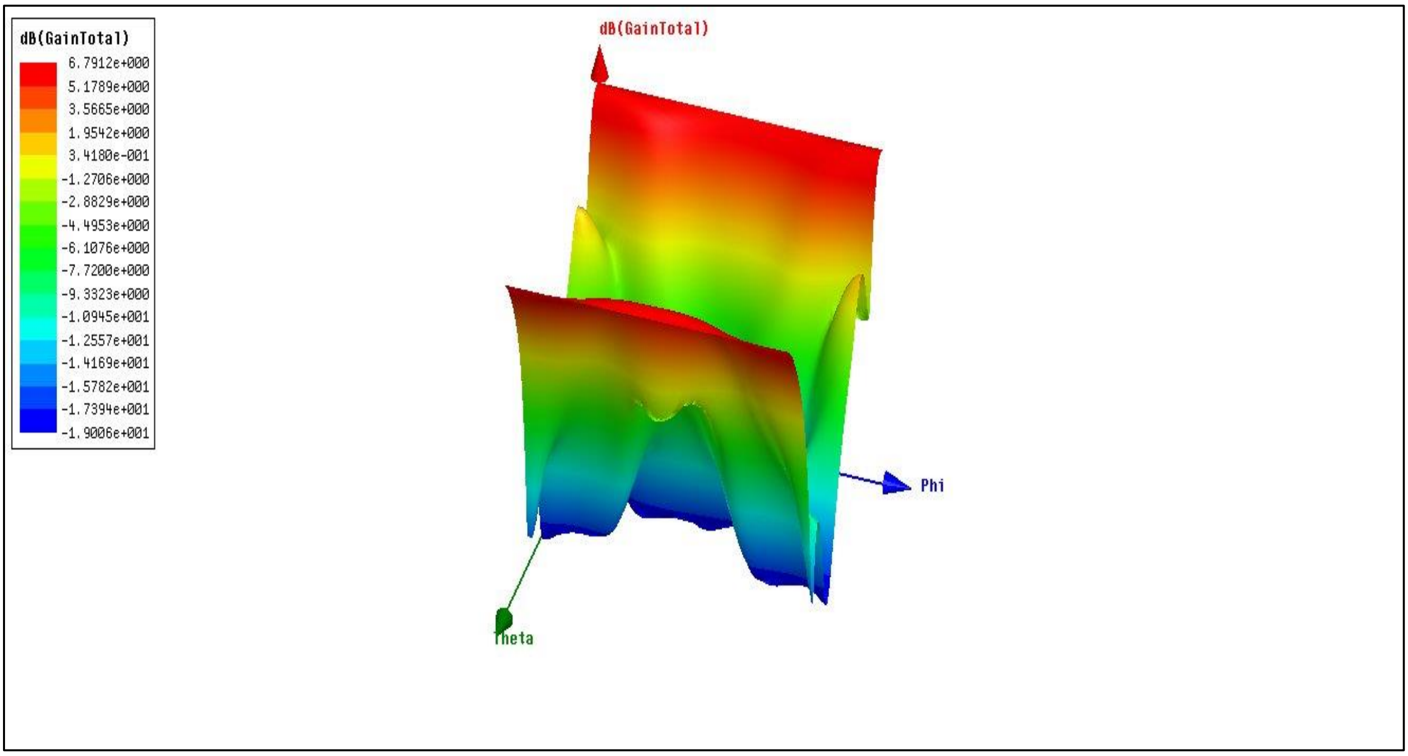
➢ *Gain*

The power transmitted per unit solid angle is the only definition of gain. Figure 6 displays the 3D Gain for the Circular Patch Fractal Antenna that corresponds to Figure 3. For all applications, the gain of any antenna is more than 3dB. 4.7 dB at 10 GHz, 6.79 dB at 32 GHz, and 8.1 dB at 32 GHz are the recorded gains for this antenna.



a) 10.4 GHZ



b) 16.5 GHZ

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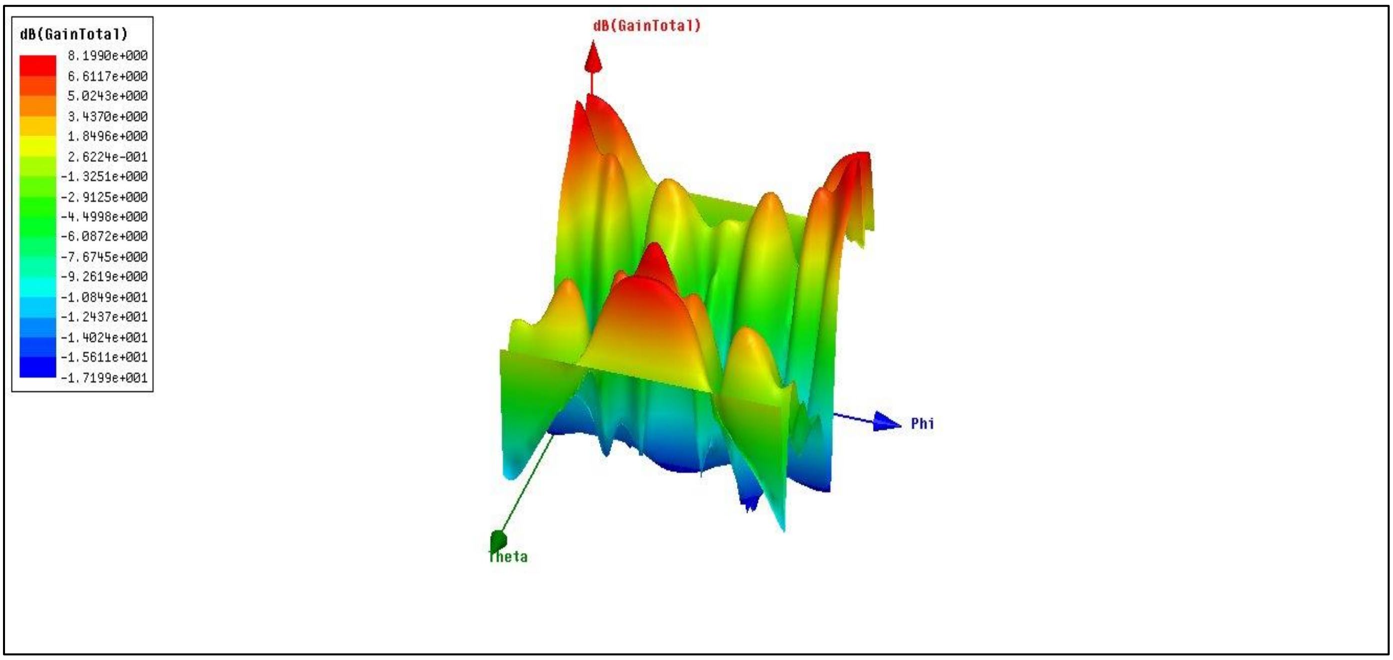
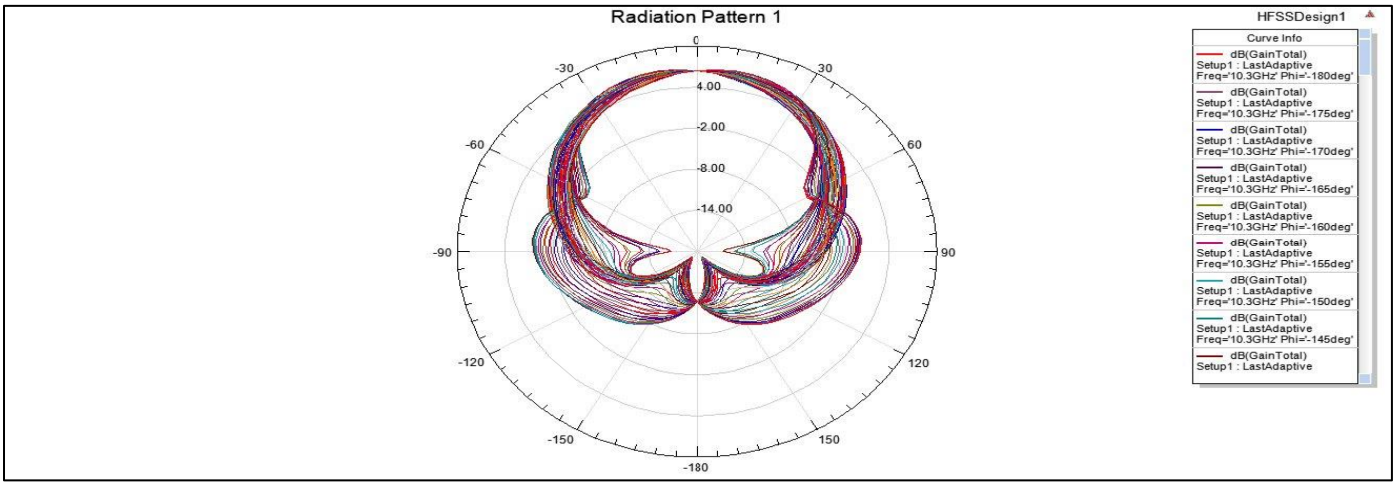


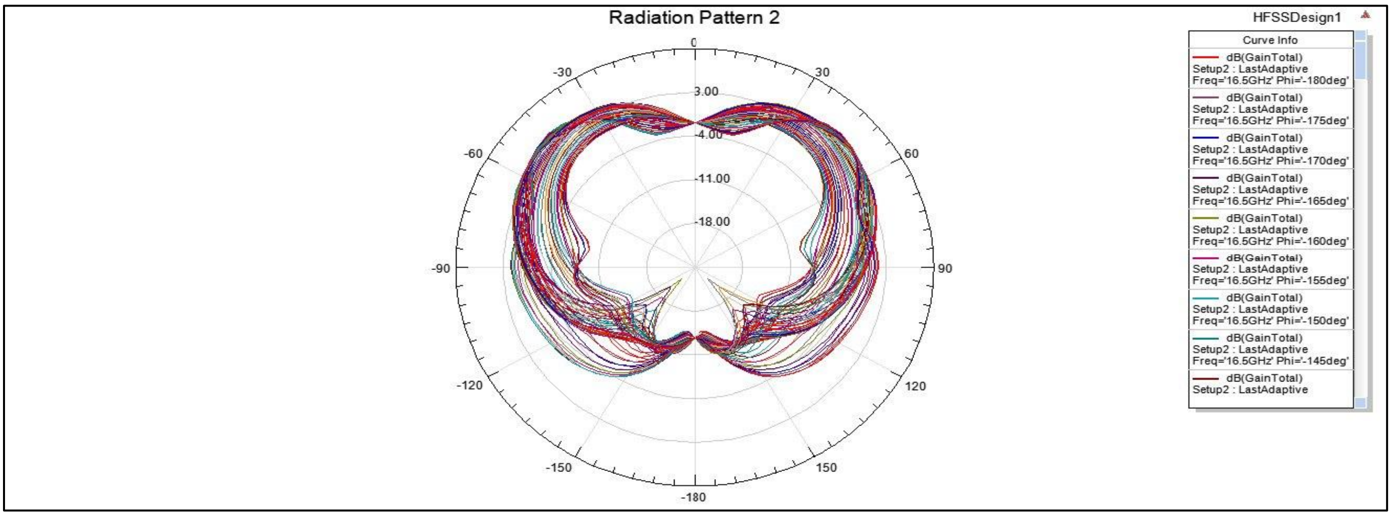
c) 22 GHZ

Fig 6 Gain of Circular Patch Fractal Antenna

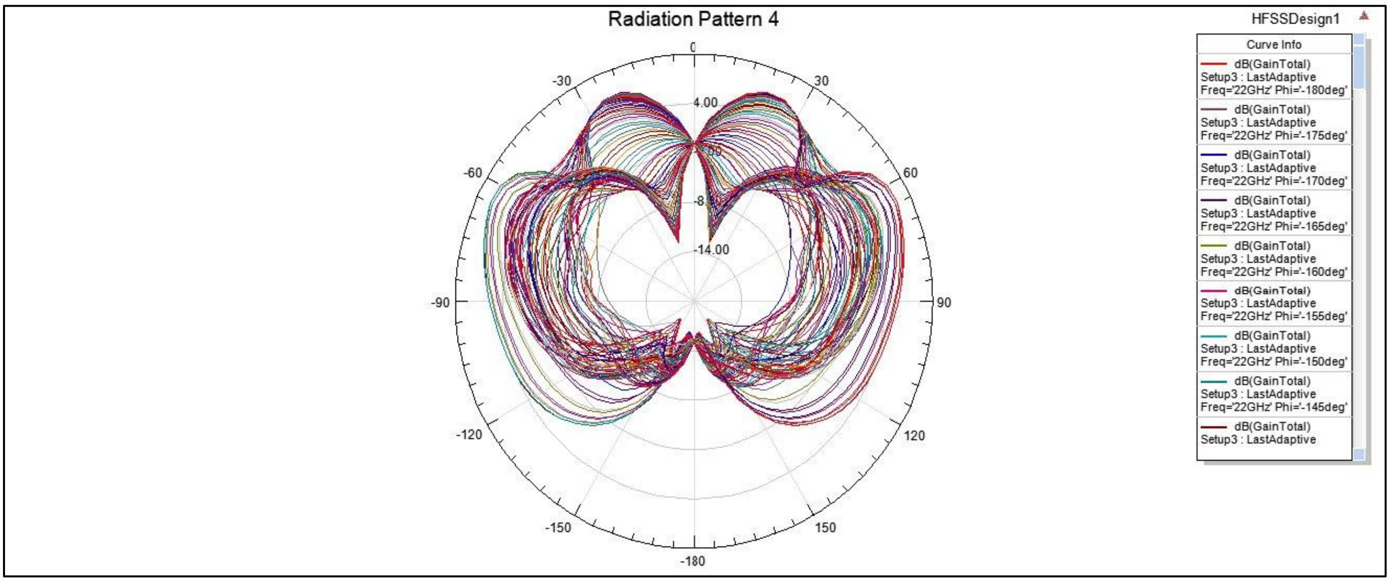
➤ *Radiation Pattern*



a) 10.4 GHZ



b) 16.5 GHZ



c) 22 GHZ

Fig 7 Radiation Pattern of Circular Patch Fractal Antenna

The change in power emitted by an antenna as a function of distance from the antenna is known as a radiation pattern. The far field of the antenna shows this power variation as a function of arrival angle. Figure 7 displays the Radiation Pattern for the Circular Patch Fractal Antenna.

VI. RESULT ANALYSIS

The reference articles discuss fractal antennas and compare the S11 and antenna gain in the analysis above. When compared to fractal antennas, which are the reference, antenna gain is higher in the proposed study.

Table 1 Result Analysis

Ref	S11 (dB)	VSWR	Gain (dB)
1	-10	<2	3.3
2	-15.77	<2	3.34
3	-27.71	<2	4.24
4	-32	<2	4.15
5	-22	<2	5.14
Proposed Work	**-27.82**	**1.4**	**8.1**

VII. CONCLUSION

It has been proved that a Multiband Circular Patch Fractal Antenna may be configured to function at various resonance frequencies in the X, Ku, K, and V bands. When compared to other current state-of-the-art antennas, the suggested antenna exhibits a huge bandwidth and strong antenna gain. With a good return loss, the proposed antenna exhibits a better radiation pattern. The suggested antenna's effective area is 15.28% smaller than that of the circular patch antenna.

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