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A Circular Shaped Fractal Patch Antenna for Multiband Applications

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Abstract: ***The principle purpose of this paper is to design a microstrip patch antenna using the circular fractal shape through HFSS software so that the designed antenna would be beneficial in multifarious bands with low cost, less physical size and most vitally high bandwidth. The results obtained are also very close and even accurate to match with the current world.***

Keywords: Fractal, S-parameters, UWB, return loss

I. INTRODUCTION

Microstrip patch antenna has diverging patch on one aspect and ground on the opposite. Modern communication systems need antennas for multiband applications and smaller dimension [1-5]. One amongst the most important application for ultra-wide band communication systems is associated with UWB antenna [12]. Typically, wideband antennas have multiple bands of frequency. If the size of antenna is smaller than 1/4th of wavelength, then the antenna cannot be economical. Moreover, mathematical applications of geometry may be a superb resolution to fabricate both antennas of multi-band and of those low profile. Applying fractal geometry to antenna parts permits not only for puny size and having multiple bands but also broad-band properties. Hence, this can be the explanation to describe analysis on antennas design in recent years [13-16]. The patch is usually rectangular, circular, square, Trapezoidal, triangular and elliptical or some other shared structure to judge the performance. In the current sophisticated world of communications, one will come across varieties of antennas with different bandwidths and with different applications. There are very few antennas in the current world which provide applications in multi bands. This is the reason behind this current proposed antenna. This antenna has been designed in various bands which provide ease of communication for various multiband purposes.

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The bandwidths obtained are absolutely fruitful and even the fabrication is spot on which implies that the fabrication is very easy to make in the industry. The results obtained are also very close and even accurate to match with the current world.

II. RELATED WORK

The aim of this paper is to construct the antenna across all the six resonating frequencies and later obtain the same results viz. S-parameter, radiation patters and the bandwidths such that the designed antenna can be used in multifarious bands. There are many disadvantages of existing System such as space limiting problem, The antenna size is too large, manufacturing cost is high, and bandwidth and gain are high etc. The proposed antenna is used for wireless applications and various multiband applications. In antenna language, a super wideband is defined as an antenna whose bandwidth ratio is greater than 10:1 in magnitude. Hopefully, majority of the antennas that are getting designed lately are in replete with these figures. Now-a-days, antenna with sensible characteristics, low value and tiny size is a crucial element and plays a key role in wireless communication. Besides exploiting the waveband of 3.2 to 10.59 GHz for ultrawideband applications, the current users of wireless communication technology square measure thirstily sorting out a brilliant wide band antenna (SWB) to hide each the short and long vary transmission for multiband and everywhere present applications. SWB technology is turning into a lot of necessary to several potential applications attributable to larger data rate, higher time exactitude etc. associate degree antenna with the information measure magnitude relation larger than a ratio of ten to one for electrical phenomenon information measure at ten sound unit come back loss is called a SWB antenna. The SWB applications can be greatly achieved with the help of monopole antennas. All the properties of super wideband antennas like low profile, less physical size and most importantly high bandwidth and good bandwidth ratio can be achieved. In this work a phi shaped super wideband monopole antenna and relative analysis of both circular and rectangular shape of patch antennas has been given in X band. Soh et.al proposed comparative radiation performance of different feeding techniques for a microstrip patch antenna [1]. Inverted S-Shaped Compact Antenna for X-Band applications has also proposed [2]. U-slot circular patch antennas with L-probe feeding techniques was proposed for ultrawideband applications [3]. It is assumed that the considered feeding locations are mostly specified well within the electric field.

The exact location of the concentric ring in order to meet the characteristics of the input resistance of nearly fifty ohms is also supported specifically that the electric field should be the higher. Thus, the location and position of the feed is produced on the patches in such a way that they are 26 mm linear from the middle at the end.

Performance investigation of microstrip antennas using various structure of Patch is proposed by Fotedar et.al at 2.4 GHz frequency and the array expression factor plays a pivotal role as mentioned in [4]. Numerous research work is continuously carried out in this field time to time and many new concepts are emerged as an outcome [5-16].

III. DESIGNING OF FRACTAL PATCH ANTENNA

There are multifarious and different microstrip patch antennas. The one which is vastly used around the world is the sierpinski patch antenna. The spectacular thing about this is that it is hugely used in diverse communication systems. The SWB applications can be greatly achieved with the help of monopole antennas. The magnitudes of physical terms such as dielectric constant and bandwidth ratio can be referred from [2]. The physical shape of the SWB monopole antenna is observed as shown in Figure 1. By manipulating the surface plane and the patch of the antenna, the required reduction in the physical size and the bandwidth is obtained. The patch of the antenna and the surface plane are carved on the front and the beneath surfaces of the substrate with a general thickness of 0.7mm and coming to the relative permittivity, 2.5 is generally taken. Geometry of the monopole antenna for SWB applications is shown in Figure 1 and proposed antenna is shown in Figure 2.

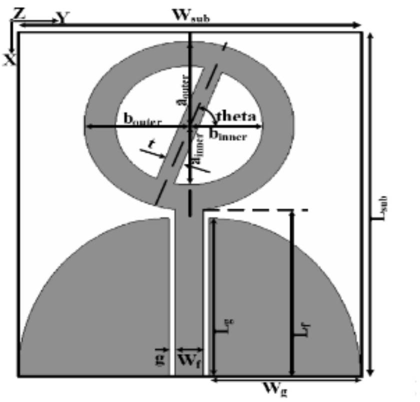

Figure 1 Geometry of the monopole antenna for SWB applications

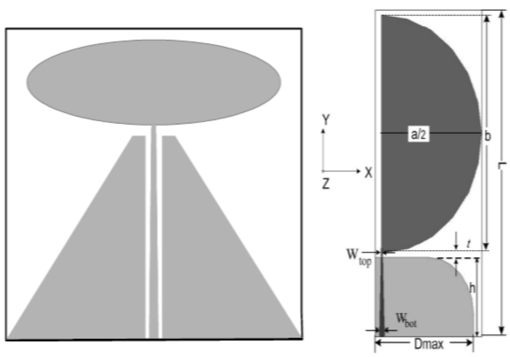

Figure 2. The monopole antenna considering ellipse shape and our proposed antenna

In addition to that, our proposed antenna meeting the requirements of reduction in the physical size and bandwidth. It could be fabricated easily on an epoxy substrate of thickness nearing to 2mm but not close to it. The SWB applications can be greatly achieved with the help of monopole antennas. All the properties of super wideband antennas like low profile, less physical size and most importantly high bandwidth and good bandwidth ratio can be achieved. A phi shaped super wideband monopole antenna has been presented in [1]. The Coplanar wave guide has been chosen for the feeding technique due to its tremendous applications like minimal effort in fabrication etc. The magnitudes of physical quantities can be referred from [2]. It has been discovered that the bandwidth expands with the increase in the corner frequencies. The length of the sides of the emission patch of our proposed antenna, which is in the shape of an octagon can be measured as,

$$r_{eff} = \frac{1.841c}{2\pi f_r \sqrt{\varepsilon_{eff}}}$$

Where r_{eff} is the length of the sides of the emission patch, c is the velocity of light, f_r is the resonating frequency of antenna and ε_{eff} is the effective dielectric constant of material. The geometry and structure of the proposed microstrip patch antenna looks something very similar to the figure 3 which is obtained through fractal geometry.

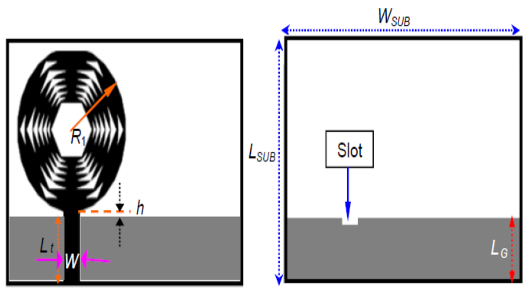

Figure 3: The structure and geometry of the patch antenna

The geometry of Proposed design of patch antenna using circular fractal shape is shown in Figure 4.

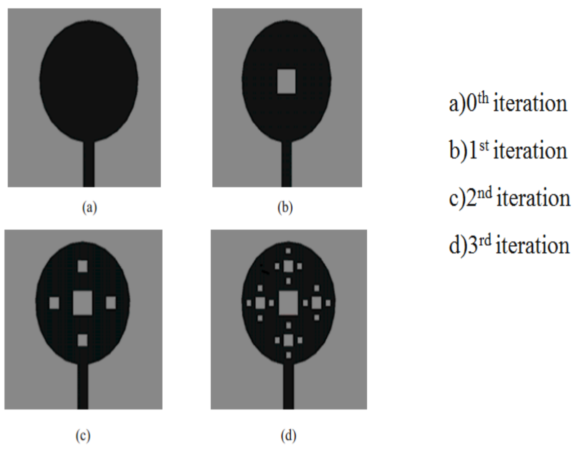

Figure 4. Fractal Antenna using circular shape

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IV. RESULTS AND DISCUSSION

The simulated geometry of Proposed design of patch antenna using circular fractal shape is shown in Figure 5

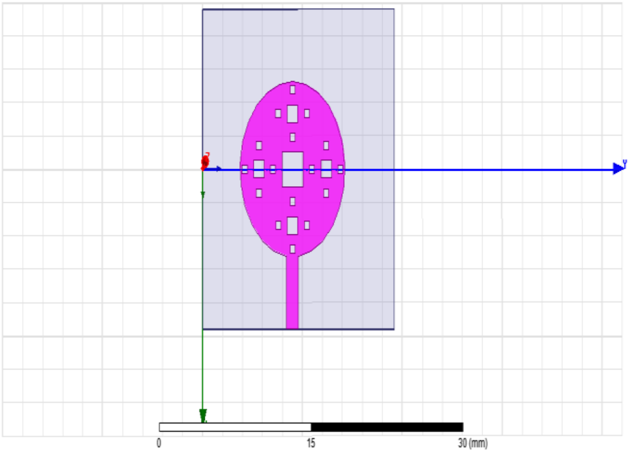

Figure 5. Optimized design of Fractal Antenna using circular shape

The simulated results are expressed in terms of return loss as shown in Figure 6 and Figure 7. It is concluded from Figure 6, the proposed antenna is very useful for multiband applications. The patch antenna resonates well at 6 different resonating frequencies between 10 GHz and 50 GHz. The return loss obtained at six different frequencies 10.2 GHz,16.5 GHz, 22 GHz, 26 GHz, 30 GHz and 48.2 GHz are 26 dB, 19 dB, 21 dB, 16 dB, 14 dB and 13 dB respectively. VSWR of antenna is represented in Figure 8. Figure 9 represent the radiation pattern of Fractal Antenna.

Return loss S11 (dB)

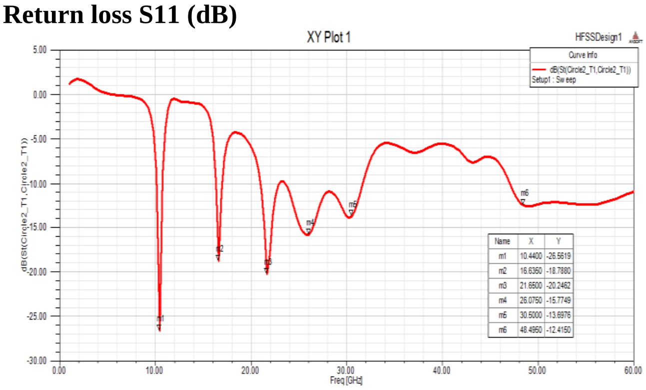

Figure 6. Return loss S11 (dB) of Fractal Antenna

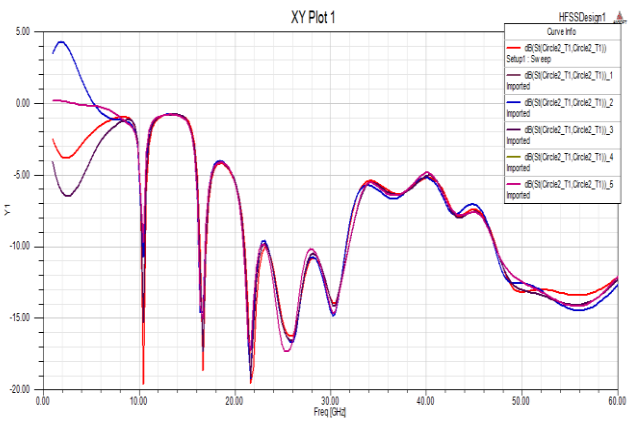

Figure 7. Return loss at different frequencies

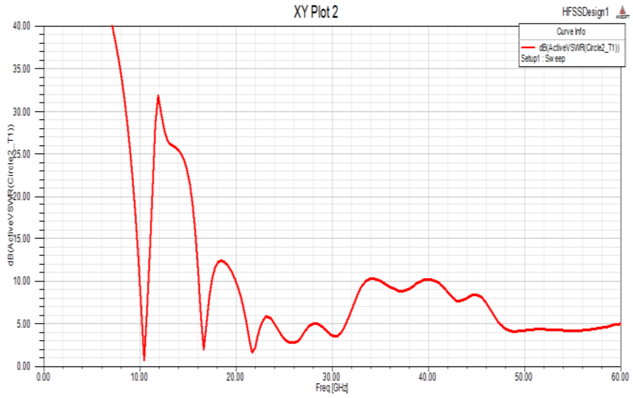

Figure 8. VSWR

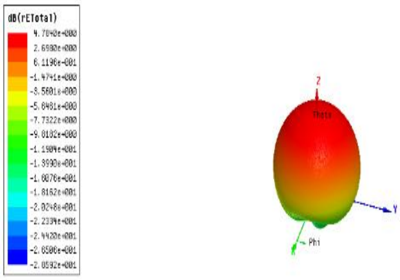

Figure 9. Radiation Pattern

Since the antenna includes a phenomenally easy structure and might be accomplished during an easy topology. The antenna design is represented in terms of the purposeful section blocks. The HFSS software has been broached to meet the specific presentation, while allowing the general dimensions of the antenna mounted, the unrelated sections gave tremendous introspections in the field of engineering and technology which further might be fabricated or changed virtually severally. The purposeful section block approach provides a strong tool to regulate the antenna characteristics like matching of the resonance, information measure widening, optical phenomenon alleviation, and SWB patterns manipulating. Based on geometry, a brilliant band form micro strip antenna is enforced. The planned style could be very next to the first iteration which directly correlates to our proposed geometry of the octagon. The planned infrastructure incorporates a size of six by six. The reproduced outcomes are acquired from Computer Simulation Microwave Studio software. The outcomes explain that it is multi-band antenna that can be gloriously applicable for the frequencies anywhere in between 10 GHz and 50 GHz which is mentioned earlier in this work. The proposed microstrip patch antenna is candid and very easy to implement. In the future enhancement process, the **FR-4 substrate** and the dielectric constant of 4.4 is used for enhancement of the frequency of the antenna and implement the one more iteration in the antenna process. One of the principle factors behind usage of the fractal geometry method was primarily due to its two phenomenal properties.

One is self-similarity and the other is nothing but space filling characteristic. The circular patch fractal tremendously improves the frequency band and it is called multiband antenna. All the antennal properties including bandwidth, gain, radiation patterns and VSWR will be calculated at the time of designing of the antenna in HFSS or CST microwave studio can also be taken.

V. CONCLUSION

The previous research work has been studied intensely and the requisite antenna has been designed and only then simulated using the High Frequency Software Simulator 13.0 version. Using the software, we have achieved the state-of-the-art antenna in which circular shaped patch is used for fractal shape. The results declare that the antenna can be used for multifarious multiband applications over the six resonant frequencies X, Ku, K and V bands. The bandwidth results are also satisfied with the current global technological development and can be applicable in various wireless applications. Low cost, easy fabrication, small sizes are also some of the key features of designed antenna.

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Dr. Vivek Singh Kushwah received his B.E. degree from Rajiv Gandhi Technical University, India in 2005, M. Tech. degree from Madhav Institute of Technology and Science, Rajiv Gandhi Technical University, India in 2007 and Ph.D. degree in Electronics Engineering from Madhav Institute of Technology and Science, Rajiv Gandhi Technical University, India in 2016 respectively. He is now working as an Associate Professor in Electronics and Communication Engineering Department, and Research Coordinator at Amity School of Engineering and Technology, Amity University Gwalior, M.P., India since 2011. He has more than 12 years of teaching experience in academics. His areas of interests include Artificial Neural Networks, Microstrip Antenna, R.F. and Microwave Filters. He is associated with many IEEE international conferences around the world as conference committee member. He is member of academic council of P.K. University Shivpuri nominated by MP Private University Regulatory Commission, Govt of MP, Bhopal, India. He is also editor of many international journals like International Journal of Communication Systems and Network. He is member of many professional bodies such as IEEE, IETE and IET etc. He filed a patent (Patent Application No.: 201911011649) on the topic "4-port meandered shared radiator for extremely high frequency applications" on 26/03/2019. He published international book chapters and more than 60 research papers in various reputed international and national indexed journals and conferences throughout the world. He attended around 50 FDPs and workshops and reviewer of various SCI indexed international journals like **IET** Microwaves, Antennas & Propagation, PIER/Progress in Electromagnetic Research, International Journal of Electronics, Taylor & Francis, Advanced Control for Applications, Wiley Publication, International Journal of RF and Microwave Computer-Aided Engineering etc.

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