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HEXAGONAL FRACTAL ANTENNA ARRAY FOR UWB APPLICATION

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ABSTRACT
This paper represents the hexagonal fractal antenna array for UWB application. A fractal antenna is an antenna that posses a unique geometrical pattern which can be repeated to produce various iterative structure or shape with unique radiation characteristics. The hexagonal fractal antenna is based on self-similarity and space filling property of fractal antenna. The frequency band is considered from 3 to 10.6 GHz. Microstrip line feed has used to make the design of antenna versatile in term of impedance matching. This antenna has designed up to third iteration through miniaturization procedure. These iteration are designed on a dielectric FR4 epoxy substrate, permittivity $\in_r$=4.4 and height =1.6mm. It is fed by a 50 ohm microstrip line. Proper and improved result has observed at third iteration of the antenna design using the HFSS software. The simulated results are in good agreement with experimental results.

KEYWORDS: Fractal antenna, Hexagonal antenna, Microstrip feed line, Return Loss, HFSS Software.

INTRODUCTION
In modern telecommunication systems require antennas with more bandwidth and smaller dimensions compared to conventional antennas [1]. The microstrip antenna consists of a very thin metallic patch placed a small fraction of a wavelength above a ground plane. The strip and ground plane are separated by a dielectric substrate. The requirement of antennas are high gain, wide bandwidth, low cost, high performance and multiband support. In MSA has many advantages as well as some drawbacks like narrow bandwidth , low gain, low efficiency or low directivity. There are many techniques to reduce the size and increase the bandwidth without effect the antenna performance. One of these techniques is fractal [2].

The origin of word 'fractal' is from the Latin word 'Fractus' which is related to the verb fangere means to break. Fractal antennas are compact, multiband antenna and these antennas are excellent alternative to traditional antenna system. The fractal antenna can operate dual and triple band of frequency and it increase in bandwidth as well as the size of the antenna gets reduced. Therefore fractal antennas have major demand in communication system [3].

A fractal is a rough or fragmented geometric shape that can be split into parts, each of which is a reduced-size copy of the whole. There are two properties: self-similarity or space-filling. Fractal antenna uses self similar structure to maximize the length or increase the perimeter on inside sections or the outer structure of the material that can receive or transmit electromagnetic radiations within a given total surface area or volume. Certain fractals represent multiband behavior and space-filling properties as reduction in antenna size [4].

In this paper, the proposed antenna can be considered as hexagon shape. Hexagon shape is selected because Hexagon form is the most compact geometry having area coverage more than other shapes like circle and triangle. By taking simple hexagonal patch it will show good behavior. The hexagon shape patch is printed on the one of the side of the dielectric substrate and other side a ground plane is printed below the patch. Working of hexagonal fractal antenna is based on self similarity and space filling property of fractal antenna. Due to self similarity property of fractal antenna get multiple bands of frequencies. Space filling property helps to reduce the size of the antenna.

ANTENNA DESIGN

The design of the proposed antenna is based on self-similarity property of fractal antenna. The hexagonal fractal antenna is designed for UWB application. This antenna design was divided into three stages. These three stages are operating at 7.5 GHz frequency. From the first iteration comes to second iteration and from second iteration develop to third iteration. The design of third iterated antenna is shown in figure 1. The antenna is designed by using FR4 epoxy substrate having the dielectric constant 4.4. The substrate length and width are taken as 70mm and 70mm respectively.

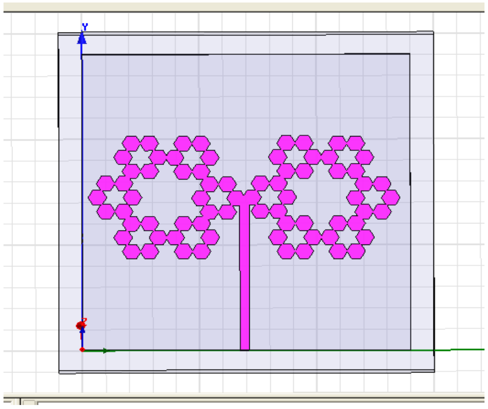
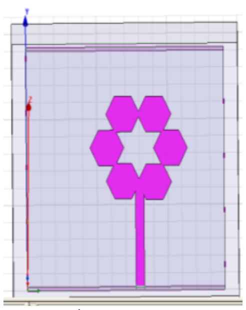
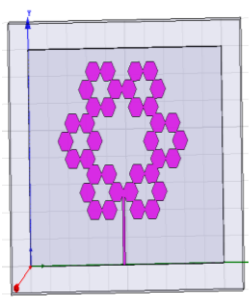


Fig 1: Geometry of proposed Hexagonal Fractal Antenna

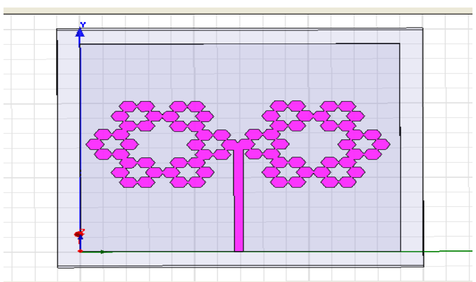
The design procedure of the proposed fractal structure geometry depicting 1st iteration, 2nd iteration and 3rd iteration are shown in figure 2.



1st iteration



2nd iteration



3rd iteration

Fig 2: Hexagonal fractal antenna with three iterations

FEEDING TECHNIQUE USED

To design the proposed hexagonal fractal antenna microstrip feed line technique is used. Microstrip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch as shown in Fig.3. It is simple to model and easy to match by controlling the inset position. Microstrip feed suffers from an impedance mismatch because the input impedance is very high compared to 50 ohm impedance of the feed line. Therefore an external impedance matching circuit is used between the patch edge and the 50 ohm micro strip line. The impedance circuit besides giving rise to spurious radiation cannot be accommodated in arrays, because of unavailability of physical space on the substrate. The micro strip line blocks the radiation from the portion of the patch with which it is in contact resulting in reduced radiation.

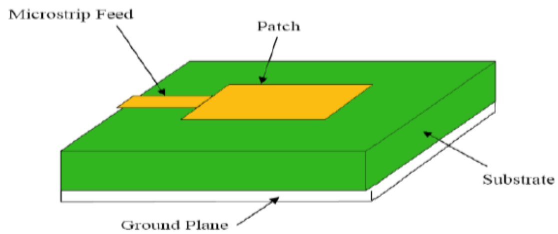


Fig 3: Microstrip feed line

SOFTWARE USED

High Frequency Structure Simulator (HFSS)

HFSS introduced from 90s and it is transfer to Ansoft HFSS after Nov.1, 2001. HFSS is a high-performance full-wave electromagnetic field simulator for 3D volumetric passive device modeling. It computes s-parameters, resonant frequency and full wave field far arbitrarily-shaped 3D passive structure and powerful drawing capabilities to simplify design entry. It consume tremendous memory if fine result is needed. It is one of several commercial tool used for model half, quarter, octet symmetry or create parameterized cross section 2D model. HFSS is an interactive simulation system whose basic mesh element is a tetrahedron. This will help us to solve any arbitrary 3D geometry, especially those with complex curves and shapes. Now a days, HFSS continues to lead the industry with innovations such as Modes-to-Nodes and Full-Wave Spice. The flow chart of Ansoft HFSS illustrates in figure 4.

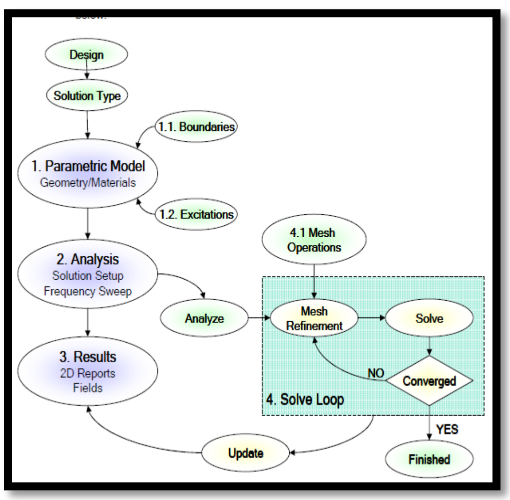


Fig 4: Ansoft HFSS project flow

SIMULATION AND RESULT

The antenna performance has been demonstrated via a Finite Element Program, HFSS. The simulation around the performance of return loss in dB, VSWR ratios and radiation pattern are carried out for the hexagonal fractal antenna. Return loss ideally should be below than -10dB. As we increase number of iterations return losses gets excellent deep. S11 is a measure of how much power is reflected back at the antenna port due to mismatch from the transmission line. A small S11 indicates a significant amount of energy has been delivered to the antenna. S11 also simply referred to as return loss. When the antenna and transmission line are not perfectly matched, reflection at the antenna port travel back towards the source and cause a standing wave form Values of S11≤ -10 dB, (VSWR <2) are considered.

The return loss for first three iterations of the hexagonal fractal antenna are plotted in figure 5. The hexagonal fractal antenna produced a high return loss.

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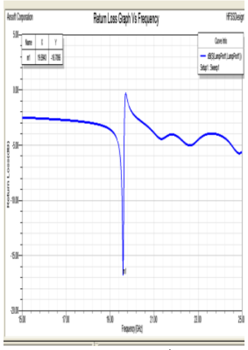
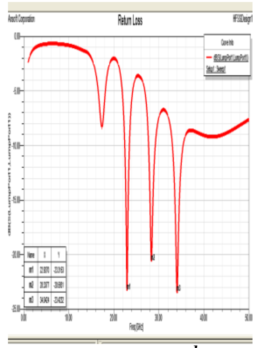
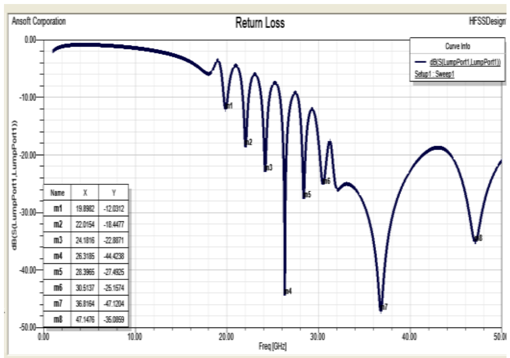


Iteration 1st



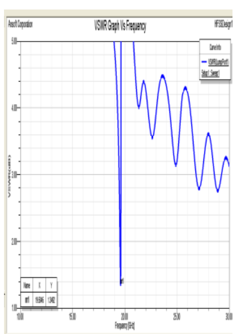
Iteration 2nd



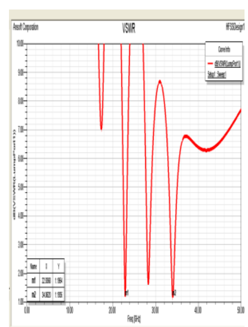
Iteration 3rd

Fig 5: Return Loss of respective three iterations

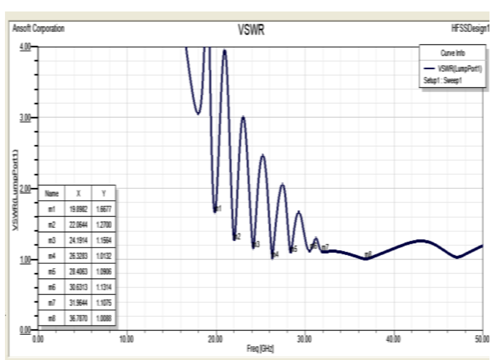
This figure show that the antenna has good VSWR performance (VSWR <2) which is required for UWB antenna. The simulated and measured VSWR values for the three iteratons of hexagonal fractal antenna is shown in figure 6.



1st iteration



2nd iteration



3rd iteration

Fig 6: VSWR of respective three iterations

The figure 7 and 8 shows the comparison of Return Loss and VSWR between three iterations of hexagonal fractal antenna. Return Loss of third iteration of hexagonal fractal antenna is better than other two iterations. It provides better impedance matching as VSWR obtained nearly equal to 1 dB.

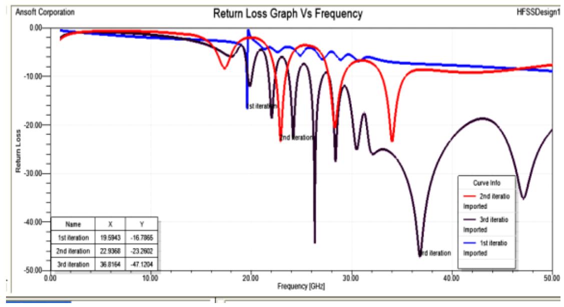


Fig 7: Comparison of Return Losses between three iterations

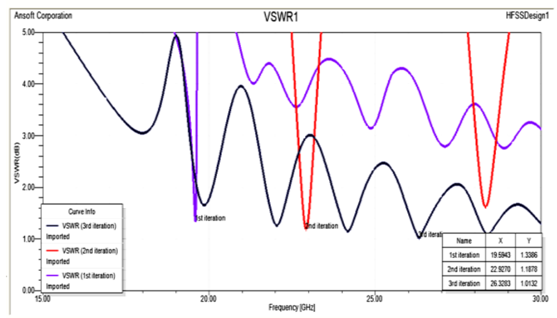


Fig 8: Comparison of VSWR between three iterations

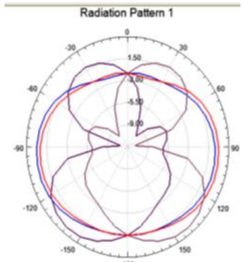
Similar to that of Return Loss, voltage standing wave ratio (VSWR) has also observed for various iterations. These observations are tabulated in following table 1.

TABLE 1

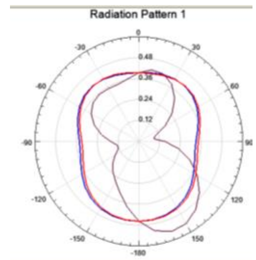
Iterations	**Return Loss(dB)**	**VSWR**
1st iteration	-16.78 dB	1.349
2nd iteration	-23.31 dB	1.193
3rd iteration	-47.12 dB	1.008

It can be observed from table, proper return loss has observed at 3rd iteration and VSWR at first iteration is very large. As we increase the number of iterations return loss gets excellent deep.

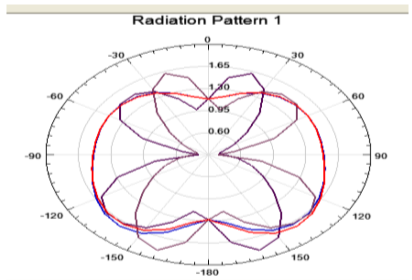
The radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. Radiation pattern determines how an antenna radiates. If the antenna is said to be Omni directional antenna then it should radiates in all directions. The patterns are usually presented in polar or rectilinear form with a dB strength scale. The radiation pattern for φ=0, φ=90, φ=180, φ=270 and φ=360 degree are shown in figure 9.



1st iteration



2nd iteration



3rd iteration

Fig 9: Radiation Pattern of respective three iterations

CONCLUSION

The Hexagonal fractal antenna has designed and studied. Characteristics of three iterations of hexagonal fractal antenna are compared. The hexagonal fractal antenna is observed to possess multiband behavior. This new fractal antenna allows flexibility in matching multiband operations in which larger frequency separation is required. It is possible with this fractal to shape and update the radiation pattern according to the environment in real time, with the aid of control algorithms, making it steerable. The simulated results have shown a good return loss, VSWR and radiation structure. The higher return loss is -47.12dB and VSWR is 1.008. The all result of simulation has been obtained by HFSS.

REFERENCES

[1] Sonu Aggarwal, Ravi Dutt Gupta, Santanu Kumar Behera, “A Hexagonal Shaped Fractal Antenna for UWB Application,” Department of Electronics and Communication Engineering, CODIS, 2012.

[2] Vikram Pal, Sunil Kumar, Sandeep Rehlan, Ashutosh Yadav, “Ultra Wideband(UWB) Hexagon Shape Planar Microstrip Slot Antenna,” International Journal of Enhanced Research in Science Technology & Engineering, Vol.3 Issue 5, May-2014, pp: 340-348.

[3] Aditi Mandal, Antara Ghosal, Anuriman Majumdar, “Analysis of Feeding Techniques of Rectangular Microstrip Antenna,” IEEE, 2012.

[4] Komal Tanwar, “Design and Analysis of Hexagonal Fractal Antenna for UWB Application,” International journal of Enginerring And Computer Science, Volume 4 Issue 6 June 2015.

[5] Deepshikha Yadav, DC Dhubkarya, “Design of Hexagonal Fractal Antenna for WLAN/WiMAX & Bluetooth Applications,” International Journal of Research in Engineering and Technology (IJRET), Volume: 03 Issue: 12, Dec-2014

[6] Kalyani S. Waghmode, Dr. S. B. Deosarkar, Prof. P. K. Kadbe, “Hexagonal Fractal Antenna for 1.6 GHz GPS Application,” International Journal of science and Research (IJSR), Volume 4 Issue 2, February 2015.

[7] Ankan Bhattacharya, “ A Novel Approach In Fractal Antenna Design Using Sierpinski Arrowhead Geometry,” International Journal of Advanced Research In Computer Engineering & Technology (IJARCET), Volume 3, Issue 1, January 2014.

[8] K. Phaninder Vinay, Basheer Ali Sheik, A. Trinadha Rao, “Design and Analysis of Slot Antenna Parameters Using HFSS,” International journal of Innovative Technology and Exploring Engineering (IJITEE), Volume -3, Issue-12, May 2014.

[9] Jagadeeshas, Vani.R.M, P.V. Hunagund, "A Self-Similar Plus Shape fractal Antenna with Hexagonal Slotted EBG Structure," International Journal of Innovations in Engineering and Technology (IJIET), Vol. 2 Issue 1, February 2013.

[10] Kalyani Sampatrao Waghmode, Dr S. B. Deosarkar, Prof. P. K. Kadbe, "Bandwidth Enhancement of a Simple Hexagonal Antenna by Using Fractal Geometry," International Journal on Recent and Innovation Trends in Computing and communication (IJRITCC), Volume 3 Issue 3,2015.