Fractal Reconfigurable Antenna

Anuradha Sonker
Assistant Professor
ECE Department
NIT Hamirpur

Shweta Rani
Associate Professor
ECE Department
BGIET, Sangrur

Sushil Kakkar
Assistant Professor
ECE Department
BGIET, Sangrur

ABSTRACT
This paper presents the use of PN junction diode on fractal monopole antenna with microstrip line for rreconfigurable multiband antennas. The developed multiband antennas focus on the applications for Wi-Fi, cordless telephone and satellite & radar. A fractal reconfigurable antenna was designed using the known fractal geometry such as Sierpinski gasket is fed by strip line using coaxial feed. Antenna's frequencies gets turn on and off with the position and biasing of PN diode on strip line. Simulations were done on the CST software for the analysis of reconfigurable patch antenna.

Keywords
Smart antennas, Slot antennas, Fractal antennas, Sierpinski gasket antenna..

1. INTRODUCTION
Antennas have become an essential and critical element of all personal electronic devices, microwave and satellite communication systems, radar systems and military surveillance and investigation platforms. In many of these systems, there is a constraint to perform a concourse of functions across several frequency bands and operating bandwidths, particularly in the area of Cognitive radio.

Reconfigurable antennas can thus provide great profitableness in applications such as cognitive radio, MIMO systems, smart antennas, RFIDs etc. The multitude of different standards in cell phones and other personal mobile devices requires compact multi-band antennas and smart antennas with reconfigurable features. The use of the same antenna for a number of different purposes, preferably in different frequencies, is highly desirable. A number of different reconfigurable antennas, planar and 3-D, were developed. Some of them were developed for radar applications [1] and other planar antennas were designed for wireless devices [2]. Most of those research works demonstrated only frequency reconfigurability. There are different types of reconfigurable antenna have been studied for ultra-wide band and multiband antennas. Slot antennas have been used for UWB frequency range. A rectangular patch antenna is modified by a slot insertion at a particular location in order to alter one resonant mode more than the other and achieve a dual-band operation. Examples of different techniques that are used to design dual-band slot antennas are presented [3]. In a single-element dual-band CPW-fed slot antenna with similar radiation patterns at both bands is studied.

A class of fractal antennas has been explored for multiband frequencies. Fractal antenna based on the Sierpinski gasket geometry is described by an infinite number of iterations of the antenna resulting in a very complex antenna structure with an infinite number of frequency bands. A single antenna with fractal concept can work as multiband antenna.

Electronic reconfigurability is usually done by incorporating switches, variable capacitors, phase shifters, or ferrite materials in the topology of the antenna [4-6]. Most frequently, lumped components such as PIN diodes, varactor diodes, or MEMS switches or varactors diode are used in the design of reconfigurable antennas. These components may be used to electronically change the frequency response, return loss, radiation patterns, gain, or a combination of different radiation parameters of such antennas.

In the present work, Siepinski gasket monopole antenna was designed at the three resonating frequencies. A PN diode has been inserted on the quarter wave microstrip feed line system. The different positions and bias of the PN diode on the quarter-wave strip line was used to turn on and turn of the resonating frequencies of the sierpinski fractal antenna to work as reconfigurable antenna.

2. DESIGN OF SIERPINSKI NTENNA
Sierpinski monopole gasket is one of the antenna structures that have got maximum interest among the fractal antenna category. The monopole antenna based on Sierpinski gasket has been considered extensively as an excellent candidate for multiband applications.

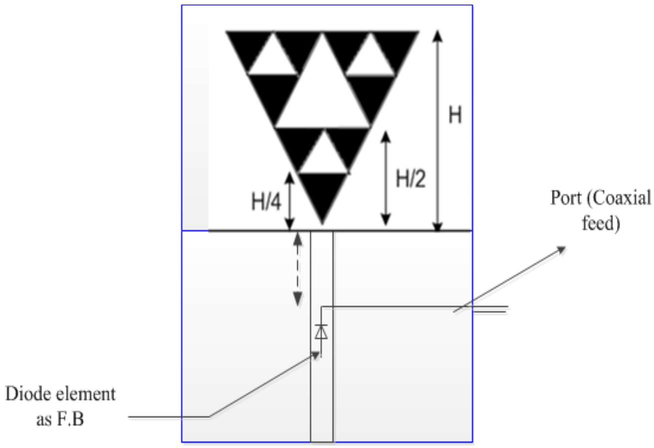

Fig.1 Front view of the Sierpinski gasket monopole antenna

The metallic gasket antenna structure is usually printed on a dielectric substrate of ε_r =2.5 and thickness was 1.5 mm. The overall height H of the gasket antenna was taken 22 mm for the designing purpose. The Sierpinski gasket monopole antenna consists of three scaled triangles having a scaling of 0.5. The heights of the scaled triangle were measured as H/2 and H/4 in the gasket antenna. These three heighted antennas operate at three resonating frequencies respectively as shown in Fig.1. In the bottom part of the antenna system, a microstrip line of λ/4 was printed on the substrate and PN diode has been placed to produce the reconfiguabilty in the antenna's resonating frequencies. The position of diode was used to turn on and off the resonating frequencies of the antenna according the biasing of the PN diode. A co-axial feed has been used to excite the structure though the ground plane on the back side of the antenna.

3. RESULTS AND DISCUSSION

The sierpinski monopole antenna resonates at three frequencies with respect to the heights of H, H/2 and H/4 respectively. The three simulated frequencies were observed as 1.8, 5.5 and 8.5 GHz respectively without diode biasing on the microstrip line. In Figure 2, S_{11} plot show the frequency response curve. All three frequencies were satisfied the accepted level of minimum return loss of 10 db.

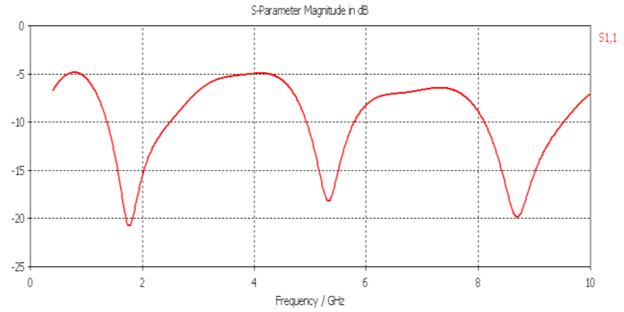

Fig.2 S_{11} vs frequency plot of gasket monopole antenna without diode

In Figure 3, when the diode is forward biased and moved at position of λ/4=22 mm on the strip line length. The impedance of the quarter wave transformer of 22 mm length matches with impedance of the overall height H of the antenna and then first frequency gets more dominating in terms of minimum (-30) db return loss due to perfect impedance matching between the antenna and feed line transformer and the other two frequencies gets less dominating in terms of maximum return loss.

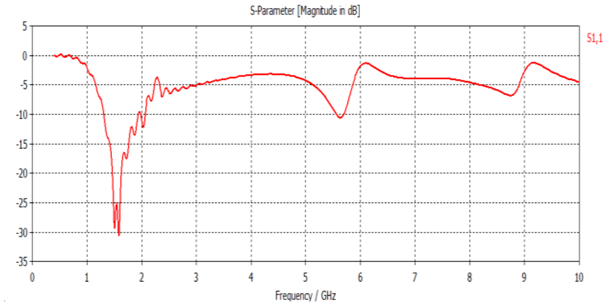

Fig.3 S_{11} vs frequency plot with diode position at λ/4 =22 mm

Similarly, when the diode is forward biased and placed at distance of λ/4 =11 mm on the strip line. The impedance of the strip line length matches with impedance of H/2 height of the antenna. So the middle frequency will be more dominating, showing the minimum -35 dB return loss with respect to the other two frequencies as shown in Figure 4.

In Figure 5, the impedance of the strip line length of λ/4 = 5.5 mm matches with the impedance of H/4 height of the monopole antenna. So higher frequency will be more dominating, having the value of -21 dB return loss.

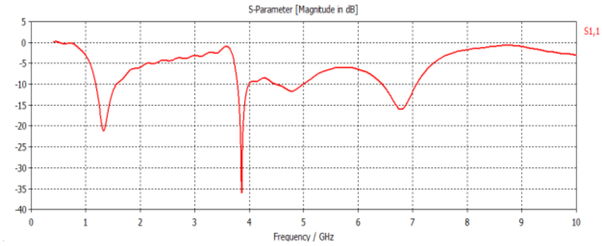

Fig.4 S_{11} vs frequency plot of gasket monopole antenna with diode position at λ/4 =11 mm

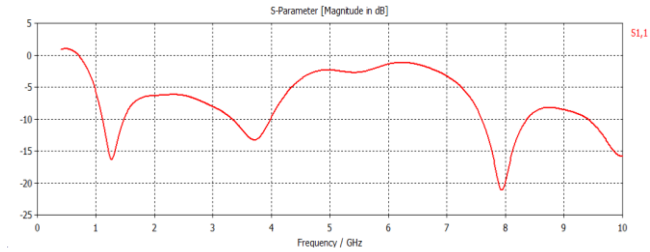

Fig.5 S_{11} vs frequency plot with diode position at λ/4 =5.5 mm

4. CONCLUSION

A reconfigurable multiple-frequency fractal antenna was designed at three frequency bands. First, the designed antenna was well-impedance matched by the proper feeding technique at all frequencies of interest. With the help of forward bias switching diode and location of diode was used to find the frequency on and off for the desirable applications. By the adopted approach, a developed reconfigurable antenna works at Bluetooth, GSM & satellite applications.

The higher iterations of fractal antenna can provide the multiple frequency reconfigurablity for cognitive radio receiver. Reconfiurability concept may be improved by the other microwave passive devices such as PIN diode with fractal antennas.

5. REFERENCES

[1] E. R. Brown, "RF-MEMS switches for reconfigurable integrated circuits," *IEEE Trans. Microwave Theory and Techniques*, vol. 46, no. 11, pp. 1868–1880, Nov. 1998.

[2] J. C. Chiao, Y. Fu, I. M. Chio, M. DeLisio, and L.-Y. Lin, "MEMS reconfigurable Vee antenna," in *Proc. IEEE MTT-S Int. Microwave Symp.Dig.* vol. 4, pp. 1515–1518, Jun. 13–19, 1999.

[3] W. H. Weedon, W. J. Payne, and G. M. Rebeiz, "MEMS-switched reconfigurable antennas," in *Proc. Antennas and Propagation society Int.Symp.* vol. 3, pp. 654–657, Jul. 8–13, 2001.

[4] E. R. Brown, "On the gain of a reconfigurable-aperture antenna," *IEEE Trans. Antennas Propag.*, vol. 49, no. 10, pp. 1357–1362, Oct. 2001.

[5] J. Kiriazi, H. Ghali, H. Ragaie, and H. Haddara, "Reconfigurable dualband dipole antenna on silicon using series MEMS switches," in *Proc.Antennas and Propagation Society Int. Symp.*, vol. 1, pp. 403–406, Jun. 22–27, 2003.

[6] C. Puente, M. Navarro, I. Romeu, and R. Pous, "Variations on the fractal Sierpinski antenna flare angle," in *Proc. Antennas and Propagation Society Int. Symp.*, vol. 4, pp. 2340–2343, 1998.