International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 4 Issue 3, March-2015, pp: (53-62), Impact Factor: 1.252, Available online at: www.erpublications.com

Design and Simulation of Reconfigurable Microstrip Antenna for Communications Systems

Dr. Sufian H. Ali
Tikrit University, Tikrit, Iraq

Abstract: The reconfigurable micro strip antenna has the ability to vary its band width, operating frequency and radiation pattern. Radiation pattern of reconfigurable antenna has the to avoid the noise sources , increasing the gain and saving power by directing the ability to switch the pattern from one direction to another at common impedance , bandwidth and operating frequency . This means the pattern is switched in any direction by one antenna beam toward the intended point. Also the fractal reconfigurable micro strip antenna, in which the radiating pattern is almost in one direction and the operating frequency will be variable. The useful characteristic of fractal antenna is the wide band frequency.

Keywords: Microstrip Antenna, Reconfigurable antenna, Radiation pattern, Communication Systems, CST.

Introduction

A micro strip antenna (MSA) is a well-known type antenna. This antenna is widely used in wireless communication system. Its advantages include low planer configuration, low volume and light weight.. The Micro strip antenna (MSA) is introduced, which is a well-known antenna's type, in which a dielectric separates a thin conducting radiator strip and a ground plane [1]. In the 1970s, The patch antenna system is developed at faster scale with wireless communications networks. New antenna types have been developed to fulfill the growing demands of the market and the reconfigurable antenna is one such kind. In general, reconfigurable antennas can be defined as an antenna that has the ability to vary its bandwidth, operating frequency, and radiation pattern in order to achieve the applications requirements [2]. These types of antennas have significant advantages such as beam forming, small size, and like most patch antenna are low cost devices.

Pattern reconfigurable antenna has the ability to switch its pattern from one direction to another at common impedance, bandwidth and operating frequency [3,4]. This characteristic can be applied in many applications with minimum hardware and system adaption. For example, multiple antenna parts integration on one device is easy using reconfigurable antennas [5,6]. Also, this type of antennas can be used to support over demand in certain directions by switching the radiation pattern to the required direction.

The research described in this paper is divided into two parts; part one is based on the development and design of a reconfigurable patch antenna, where its configurability is the defined by the changing direction of radiation pattern at each operation states of the switches. Usually, radiation pattern of reconfigurable antennas can be controlled through switches such as RF MEMS. This switch provides the best isolation in off state, the lowest power consumption, and the highest conductance in on state comparing the other types [7].

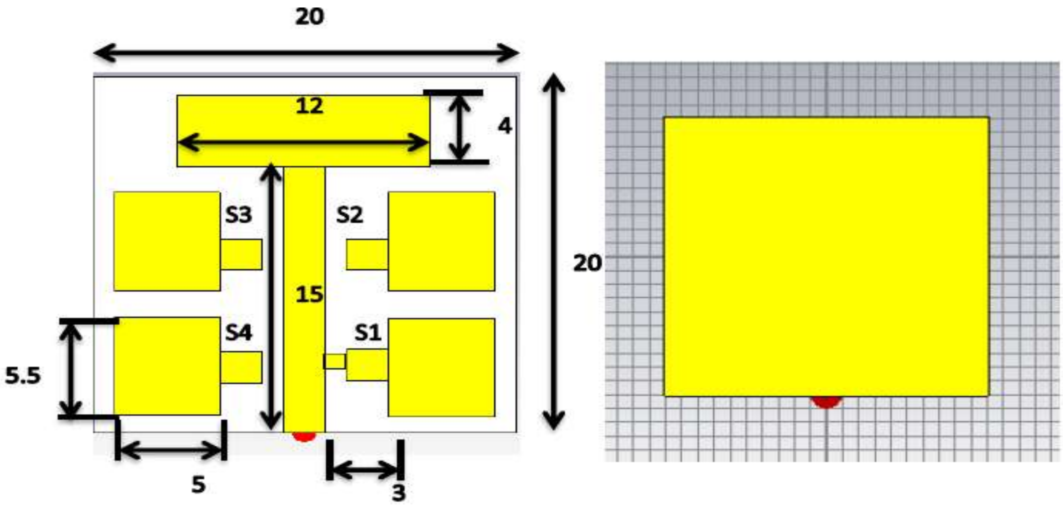
The second part is to design a tree fractal antennas in which the radiation pattern will be almost the same and the operating frequency on the other hand will be variable depending on the number of switched activated at each case [8]. Fractal antenna is subdivided in parts, each of which is a reduced size copy of whole [9].

Reconfigurable antennas design and simulation

The design and simulation of the reconfigurable antenna vary one of the following: frequency operation, impedance, bandwidth, beam forming or radiation pattern direction [2]. In this paper the radiation pattern and operating frequency re-configurability is the point of interest. The program CST (computer simulation tool) is used to design and simulation of two antennas as follow:

A. The first antenna shown in Figure 1includes four patches in the left and right of feeding line, which are feeding by switches to the feeding line and one patch at the top of antenna.

International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 4 Issue 3, March-2015, pp: (53-62), Impact Factor: 1.252, Available online at: www.erpublications.com



Front View Back View

Figure 1 . Front and back view of micro strip antenna

The first case is to connect the switch S_1 and other switches are disconnect as shown in Figure 1. The curve of s_{11} parameter (return loss) with two resonant frequencies show in Figure 2. Figures 3 and 4 shows the radiation patterns of first and second frequencies.

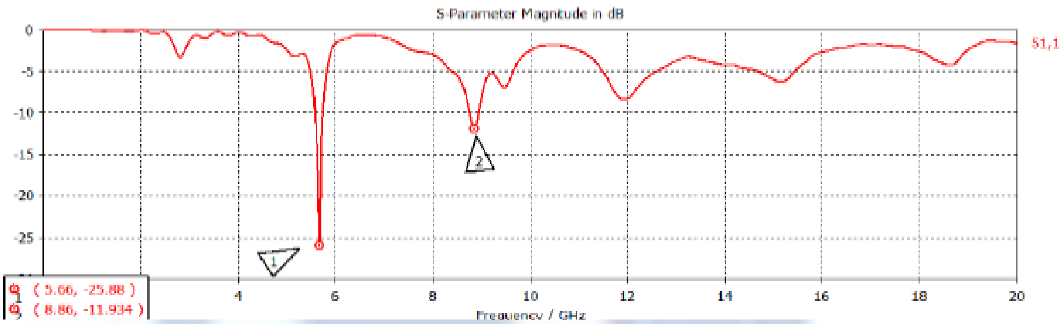


Figure 2 . s_{11} parameter when S_1 in ON-state

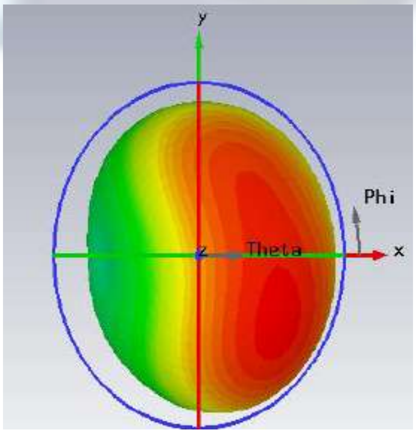


Figure 3: Radiation pattern for frequency 5.7 MHZ when S_1 in ON-state

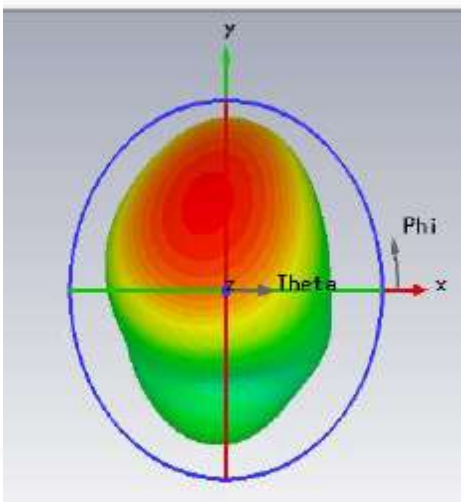


Figure 4 . Radiation pattern for frequency 8.86 MHZ when S_1 in ON-state

The second case is to connect forth patch , by switch S_4 which is the opposite of the first case discussed above. Figure 5 shows the curve of s_{11} parameter. The Figures 6 and 7 shows the radiations patterns for two resonant frequencies.

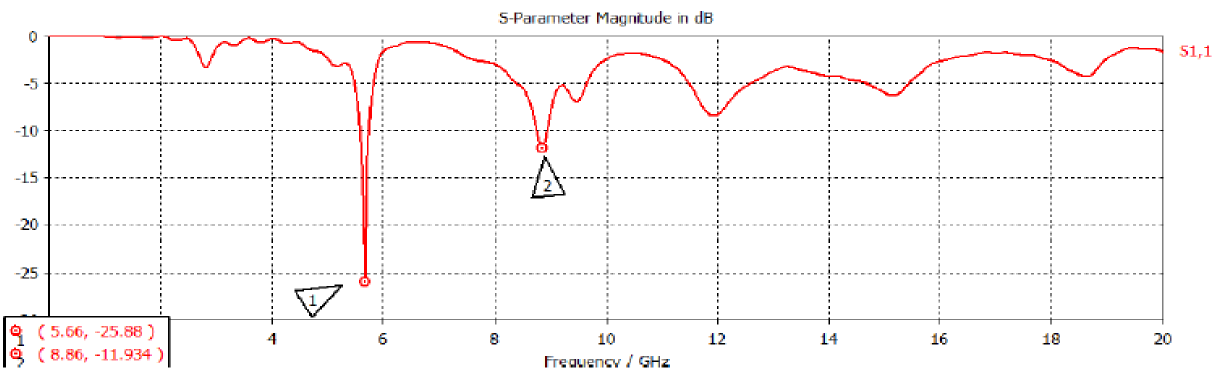


Figure 5 . s_{11} parameter for frequency when S_4 in ON-state

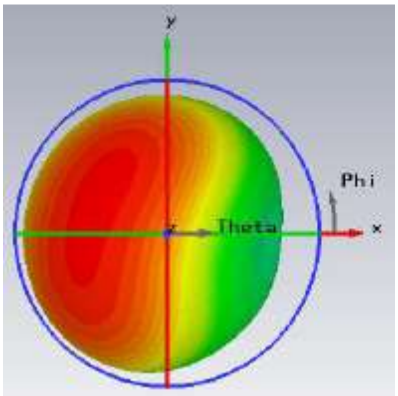


Figure 6 . Radiation pattern for frequency 5.66 MHZ when S_4 in ON-state

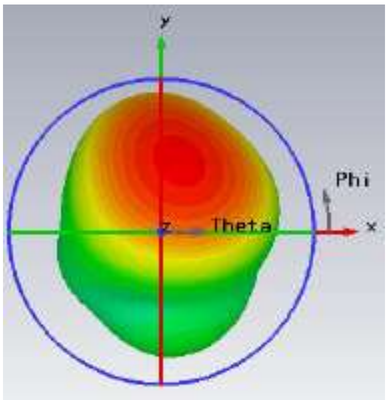


Figure 7. Radiation pattern for frequency 8.86 MHZ when S_4 in ON-state

The third case when S_3 and S_4 will be connected at the same time. For this case the curve of s_{11} parameter with resonant frequencies shown in Figure 8. The radiation patterns of resonant frequencies are shown in Figures 9 , 10 and 11.

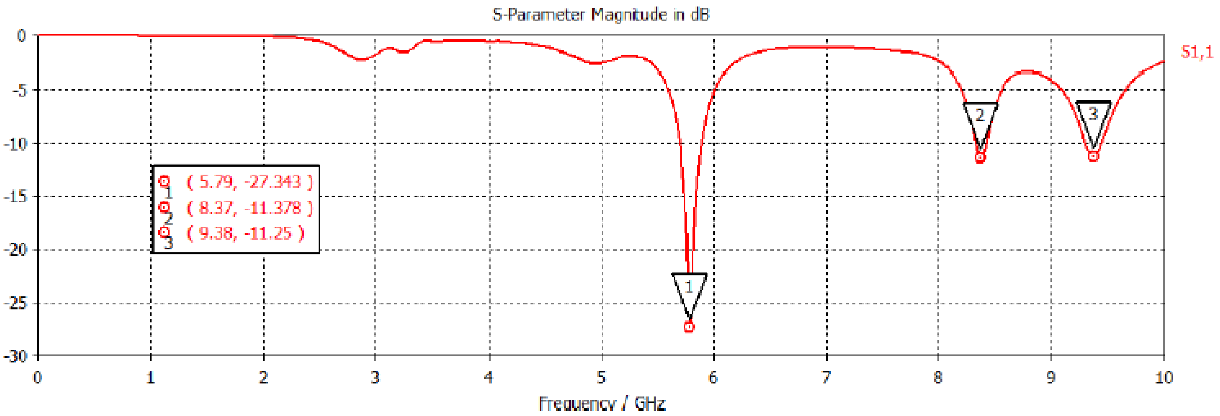


Figure 8 . s_{11} parameter when S_3 and S_4 are connected at the same time

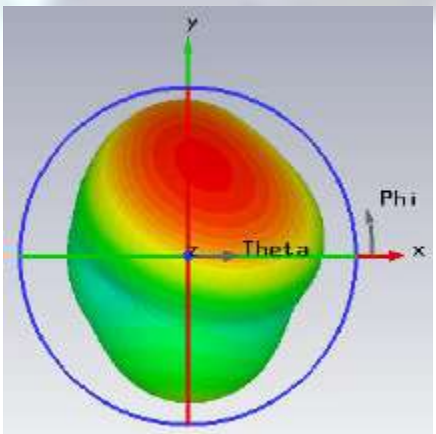


Figure 9. Radiation pattern for frequency 8.37MHZ when S_3 and S_4 in ON-state at the same time

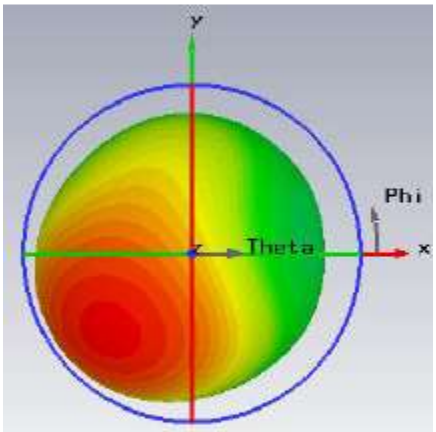


Figure 10. Radiation pattern for frequency 5.98MHZ when S_3 and S_4 in ON-state at the same time

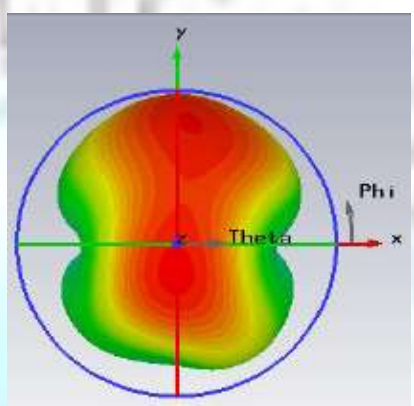


Figure 11. Radiation pattern for frequency 9.38 when S_3 and S_4 in ON-state

The forth case when S_2 , S_3 and S_4 are connected at the same time.. For this case the curve of s_{11} parameter with resonant frequency shown in Figure 12.The radiation pattern of resonant frequency is shown in Figure 13.

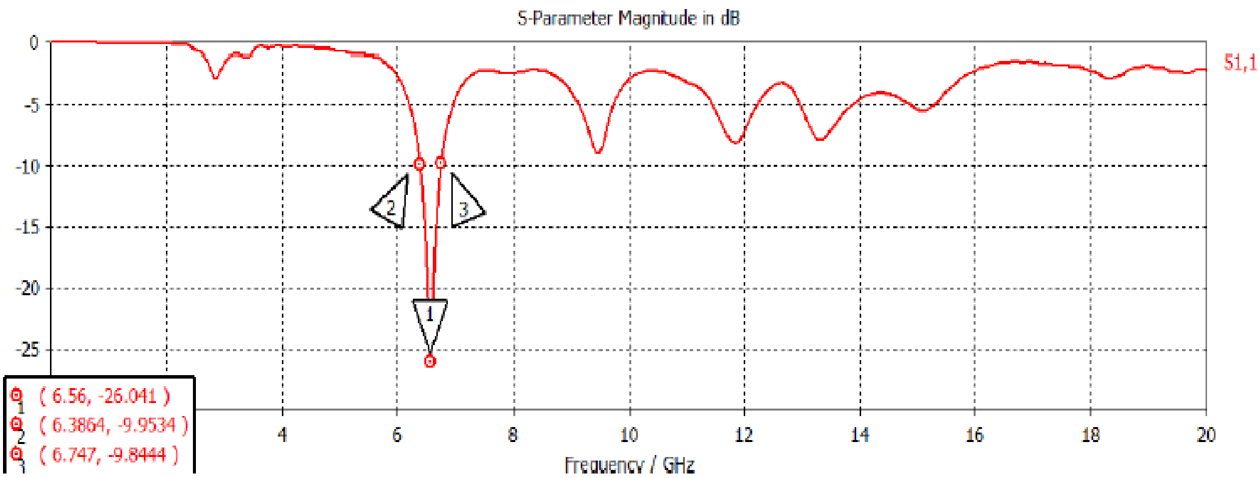


Figure 12. s_{11} parameter when S_2, S_3 and S_4 in ON-state

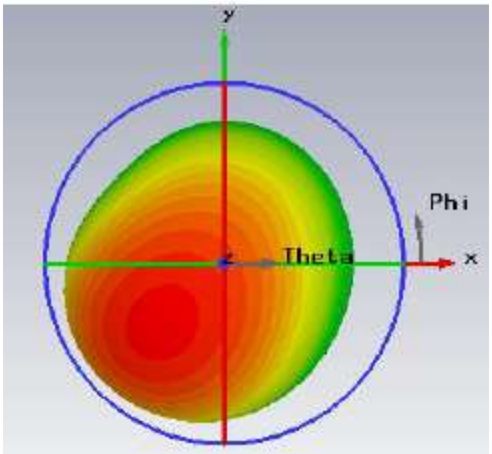


Figure 13. Radiation pattern for frequency 9.38 when S_2, S_3 and S_4 in ON-state

B. The fractal reconfigurable cedar- shaped micro strip antenna .This antenna with symmetrical slots and RF switches [11].

The first case when all switches in OFF- state shown in Figure 14 .

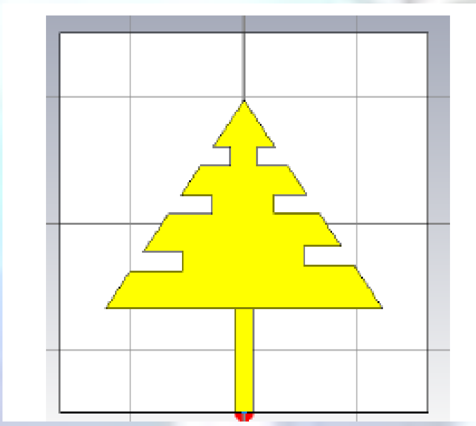


Figure 14. Fractal antenna when all switch in OFF-state

The curve of s_{11} parameter for this case shown in Figure 15 and has three resonant frequencies , 1.85GHZ, 2.96GHZ and 4.19GHZ. The radiation patterns for last three frequencies are the same as shown in Figure 16.

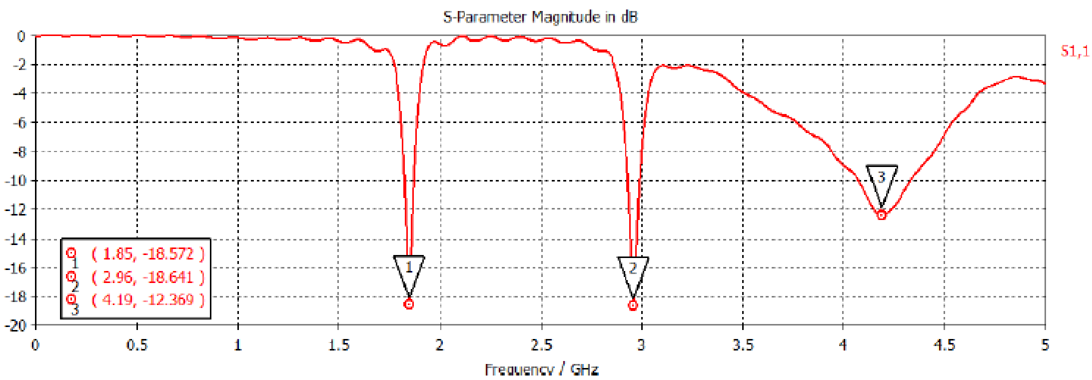


Figure 15. s_{11} parameter for fractal antenna when all switches in OFF-state

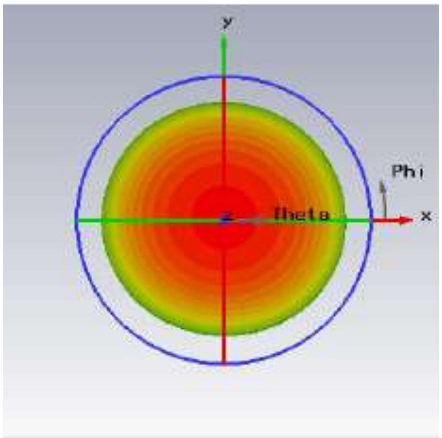


Figure 16. Radiation pattern of fractal antenna for frequencies 1.85, 2.96and 4.19GHZ when all switch in OFF-state

The second case is to connect the switches at left bottom side as shown in figure 17.

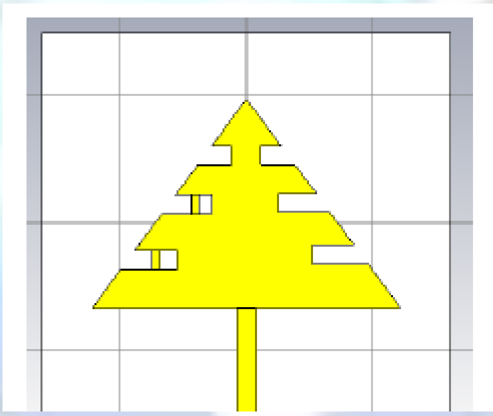


Figure 17. Fractal antenna when two switch at bottom-left side in ON-state

Figure 18 shows s11 parameter. The antenna in this case has three resonant frequencies, 1.88, 2.98 and 4.26GHZ. The radiation pattern for these resonant frequencies are the same as shown in Figure 19. The radiation patterns in Figures 16 and 19 are the same.

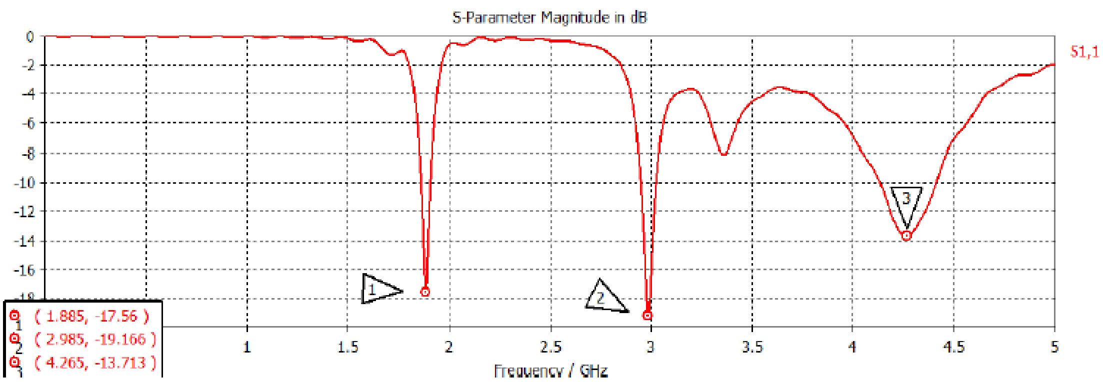


Figure 18. s_{11} parameter of fractal antenna when two switch at left side in ON-state

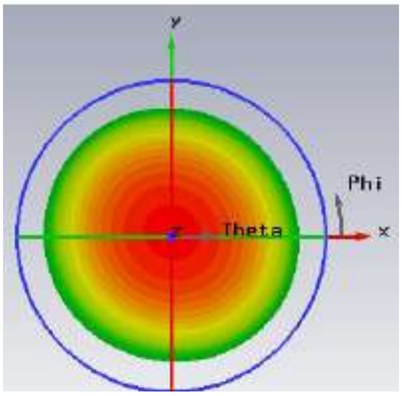


Figure 19. Radiation pattern of fractal antenna for frequencies 1.87, 2.98 and 4.26GHZ. when two switch at left side in ON-state

The third case is to be connect the switches in the left and right at the bottom of antenna as show in Figure 20.

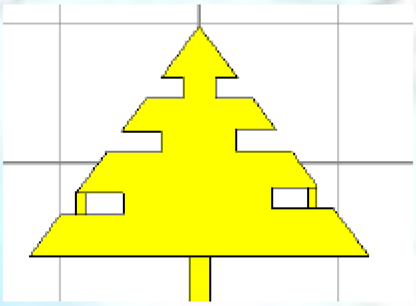


Figure 20. Fractal antenna when two switches at left and right sides in ON-state

The antenna in this case has three resonant frequencies, 1.87, 3.08 and 4.26GHZ.Figure 21shows the radiation pattern in for these resonant frequencies in this case.

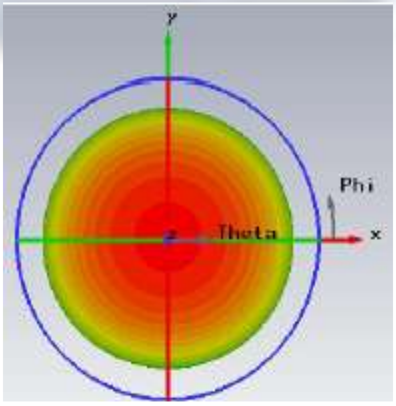


Figure 21. Radiation pattern of fractal antenna for frequencies 1.87, 3.08 and 4.26GHZ when two switch at bottom left and right sides in ON-state

The forth case shown in Figure 22. The antenna in this case has three frequencies, 1,91, 2.97 and 4.39GHZ.

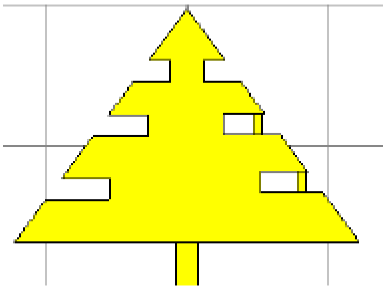


Figure 22. Fractal antenna when two switches at d right side in ON-state

The fifth case shown in Figure 23. The antenna in this case has three frequencies, 1,91, 2.94 and 4.22GHZ.

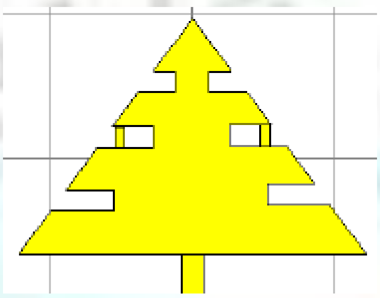


Figure 23. Fractal antenna when two switches at d right side in ON-state

The sixth case shown in Figure 24. The antenna in this case has three frequencies, 1,93, 2.99 and 4.29GHZ.

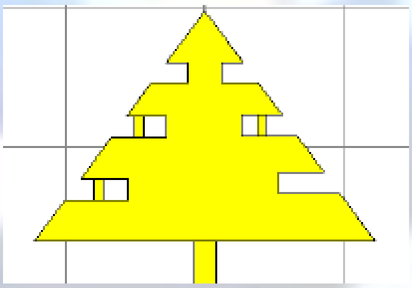


Figure 24. Fractal antenna when three switches in ON-state

Another cases not need discussed because the principle of operation are the same as.

Analysis of Results

The analysis of two antenna as follow:

a. The main reason behind achieving the change of radiation pattern direction for first antenna is the phase difference between radiating patches and surface current distribution. are the same for booth cases .The first case is to connect the first patch by switch S_1 and other switches are disconnect. The antenna with this state of connection has two resonant frequency 5.7MHZ and 8.86 MHZ as in Figure 2 of S_{11} parameter. The direction of radiation pattern for 5.7MHZ is to the right from the reader as show in Figure 3 because of the phase difference between the radiating patches and the surface current distribution which has a high intensity at the right side of the antenna. For the resonant frequency 8.86 MHZ, the direction of radiating pattern is to top left of antenna from the reader as shown in Figure 4. The resonant frequencies in the case when S_4 in ON state are 5.66 MHZ and 8.86 MHZ almost the same for previous case when S1 is connect as show in Figure 5. For 5.66 MHZ resonant frequency, The direction of radiation pattern is to the left of the reader as show in Figure 6 because of the phase difference between the radiating patches and the surface current distribution which has a high intensity at the left side of the antenna. On the other hand, the 8.86 MHZ when S_4 in ON state radiating pattern is more directive to the top right part of antenna from the reader side as shown in Figure 7. The reason behind this radiation pattern is the phase difference and the surface current flows from the attached page to the right - top part.

The case of connected S_2 and case when S_3 is connected will be not discussed , because the principle operation of these cases and cases when S_1 and S_4 are in ON state is the same.

The third case when S_3 and S_4 will be in ON stat at the same time. For this case the antenna has three resonant frequencies at 5.98 , 8.37 and 9.38 GHZ as shown in figure 8. Radiation patterns of these resonant frequencies are shown in Figures 9 , 10 and 11. Also the direction of radiation patterns depend on phase difference of radiating patches and distribution of surface currents.

The case when S_1 and S_2 are connected at the same time will be not discussed , because the principle operation of this case are and the cases when S_3 and S_4 are connected at the same time are the same.

The forth case when the S_2, S_3 and S_4 are connected. In this case the resonant frequencies at 9.38GMHZ as shown in Figure 12. The radiation pattern of this frequency shown in Figure 13.

In all cases above the structure of radiation pattern depends on the amplitude and the phase difference of radiated electric field from different points of antenna.

b. The second antenna is a fractal re configurable cedar- shaped micro strip antenna. This antenna with symmetrical slots and RF switches . By changing the places of switches, the electrical length of antenna is altered and causing the resonant frequency to be changed The radiation pattern directed to word the reader. This pattern is to be identical For all resonant frequencies .

Conclusion

New antenna types , known as the reconfigurable antenna , have been designed and studied in this paper. Reconfigurable antennas can be defined as an antenna that has the ability to vary its bandwidth, operating frequency and radiation pattern in order to achieve the application requirements. These antennas types have many advantages over regular patch antennas such as its ability to avoid detection, dual receiving mode and like most patch antennas are low cost device. Pattern reconfigurable antennas have bi-states in which the antenna has the ability to switch its pattern from one direction to another at common impedance , bandwidth and operating frequency.

In this paper two designs of antennas have been studied. The first antenna type consists of four patches connected through RF switches to feeding lines. The proposed design has shown good ability of switching the radiation pattern and keeping the operating frequency almost the same for several cases. The second design is cedar shaped micro strip antenna to achieve frequency re configurability by applying switches at antenna slots. The bandwidth of fractal antenna is increased , when the radiation pattern not change.

References

[1]. C.A. Balanis , Antenna theory : analysis and design. New York : Wily , 2005.

[2]. J.T. Bernhard , "Reconfigurable antennas , "Fort Collins, CO:Morgan and Claypool ,2007.

[3]. G.H. Huff , J.Feng , S. Zhang and J. T. Bernhard , A novel radiation pattern and frequency reconfigurable single turn square spiral micro strip antenna, "IEE Microwave and Wireless Component Letter s , vol. 13 , pp. 57-59 , Feb. 20013.

[4]. G.H. Huff and J.T. Bernhard , "Analysis of radiation frequency reconfigurable micro strip antenna ," in Proc. 2004 Antenna App. Symp., Monticello , pp. 175 – 191, 2014.

[5]. Punjala , Shishir S., "Effective Reconfigurable antenna to Enhance Performance and Enable Wireless powering ", FIU Electronic Theses and Dissertations, 2009 .

[6]. T.L. Roach1 , G.H. Huff2 and J.T. Bernhard , " On the applications for a Radiation Reconfigurable Antenna , "Second NASA/ ESA Conference on adaptive hardware and systems , 2007.

[7]. M Spasos , N Charalampidis, N Mailios, D Kampitki, K Tsiakmakis, P soel , R Nilavalan, "On the design of an ohmic RF MEMS switch for reconfigurable micro strip antenna applications " , world Scientific and Engineering Academy and Society,Vol. 8 , Issue :1, pp. 153-161, 2009.

[8]. Kraus , "Antennas", Second Edition, Mc Graw-Hill, 1988.

[9]. M.A. Madi , M. AL-Husseini, A.H.Ramadan, K.Y.Kabalan, and A.EL-Hajj, "a reconfigurable cedar- shaped micro strip antenna for Wireless Applications," Progress in Electromagnetics Research C, Vol. 25, pp. 221, 212, 2012.