Journal of Applied Research and Technology

www.jart.icat.unam.mx
Journal of Applied Research and Technology 17 (2019) 297-301

ICAT Instituto de Ciencias Aplicadas y Tecnología

Original

Characterization of compact and efficient patch antenna with single inset feeding technique for wireless applications

S. Palanivel Rajan*, M. Paranthaman

Department of Electronics and Communication Engineering, M.Kumarasamy College of Engineering, Karur-639113, Tamilnadu, India.

Abstract: Microstrip patch antenna has made great progress in recent years. Wireless applications including radars, cellular phones, wireless sensor networks, and in medical applications are used in microstrip patch antenna. The proposed antenna used for double inset feeding technique with the generation of millimeter-wave Hermite-Gaussian (HG) beams at E-band. Microstrip corporate organizes an eight microstrip patch factors are used by way of HG_{11} in feeding network. Relative permittivity of 3.75 and loss tangent of 0.018, designed antennas are simulated on a high performance of FR4 substrate. To simulate the proposed antennas are used by the ADS Momentum software. The usage of ADS Momentum is various parameters for instance S11 Parameter, return losses, directivity and gain of the proposed antennas are also obtained using ADS momentum.

Keywords: Antenna radiation patterns, Microstrip antennas, Millimeter wave propagation, Patch antenna and Radar antenna

1. INTRODUCTION

The Microstrip patch antenna is modeled as ground plane and radiating patch are separated by a substrate (Yao, el at., 2016). Low weight, low profile planar configuration, low fabrication costs and microwave integrated circuits technology has a capability of integration are some advantages of patch antenna (Rajan, & Davood, 2015). Microstrip antennas are playing an important role in telecommunication field now a day (Siddique et al., 2013). In (Bano, Rastogi, & Sharma, 2014), design of E-shaped patch demonstrates the use of this kind on Microstrip can be applicable to numerous applications like Global positioning, radar, healthcare, satellite, missiles and secured military communication services (Singh & Agarwal, 2015). In these patch antennas to improve the performance and efficiency of recent past years of research. Wireless communication has experienced good growth in the past few years (Rajan & Kavitha, 2017). Easy to design, light weight, etc. are de-merits to overcome the advantages of microstrip patch antenna. Whereas all the fields and areas are spreading and substrate material has a low cost (Singhaol & Bimal Garg, 2012). In the wide range of maximum application has due to the increasing

* Corresponding author.
E-mail address: drspalanivelrajan@gmail.com (S. Palanivel Rajan)
Peer Review under the responsibility of Universidad Nacional Autónoma de México.

usage of the patch antenna (Rajan & Dinesh, 2015). The Microstrip patch antenna has several applications are discussed as below:

For radar communication, the coverage area and the object movement detection are the major requirement. An aperture coupled patch maybe used for radar system to fulfill the requirements. While a microwave range of very high frequency is used by satellite communication (Sukanesh, Gautham, Rajan, & Vijayprasath, 2010). It is because the radio frequency gets reflected by the ionosphere (Rajan, 2014). In a global positioning system used for substrate material has a high permittivity in microstrip patch antenna. Due to it is depends on positioning circular polarization is a very compact and it's quite expensive (Vijayprasath & Rajan, 2015). While the general population for land vehicles, aircraft and to find their position accurately used by GPS receivers.

2. ANTENNA DESIGN

Patch antenna has to provide a realization approach of Hermite-Gaussian beams (Narendra, 2013) as in Figure 1. An eight array of square shaped patch antenna of area 1.58*1.025 mm^2 was designed. Feeding method to a patch and its position plays the major role in radiation of an antenna. Here inset feeding used twice as eight patches in the design. The microstrip patch antenna has designed and construct of eight identical patch antennas and it has to generate the HG11 beam, then it is designed to work at 77.32 GHz. Figure 1 is proved in double inset-fed patch. In this (Parashar, 2014) every patches are have all dimensions are kept same, but two feeds are used which are at opposite sides of each other. The inset-feed is a simple way to excite the patch and allows for planar feeding techniques such as a micro strip line. The typical feeding mechanism involves a micro strip line coplanar with the patch (Khidre, Lee, Yang, & Elsherbeni, 2013). The proposed antenna design for double inset fed technique. During this technique used for multiple transmitted and received with a signal (Annakamatchi & Keralshalini, 2018). The microstrip feeding network has a one input source in patches and it used by T-junctions are shown in Figure 1 respectively (Rajan & Sukanesh, 2013a).

The antenna patch can be made either of copper or gold (Mohanapriya & Vadivel, 2013). Here in this ADS software copper has been taken by using default as the patch material (Vivek & Rajan, 2016). Patch material is proven in brown color in the figure 1. Table 1 Showing details about the material. Patch is of copper material. Relative permittivity's 3.75 the base material is also of copper.

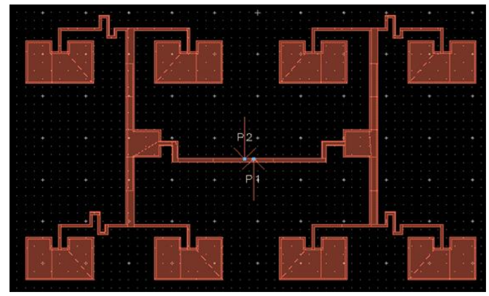

Fig. 1. HG_{11} antenna array of eight patch antenna with double inset-fed.

proven in brown color in the figure 1. Table 1 Showing details about the material. Patch is of copper material. Relative permittivity's 3.75 the base material is also of copper.

Table 1. Material Used for Patch Antenna.

Structure	Material
Patch	Copper
Substrate	(ε=0.125)

3. SIMULATION SETUP THROUGH ADS MOMENTUM

Momentum is a section of the Advance Design System and it gives the simulation tools required to consider and design products of present day communication systems (Affandi, Dobaie, Kasim, & Al-Zahrani, 2015). The structure of a simulator that computes the S-parameters are electromagnetic solver by momentum (Rajan & Vivek, 2019). In a square planar circuit which consist of microstrip, slot line, strip line, coplanar waveguides and many different topologies. While an ADS Momentum additionally simulation of multilayer communication circuits and printed circuit boards and to get an accurate result (Saxena, Agarwal, & Srivastava, 2014). The ADS Momentum optimization tool extends are real design automation tool has a capable (Rajan, & Sukanesh, 2013b). To achieving the optimal structure of automatically varies the geometry parameters in momentum optimization process that for the circuit or device performance goals (Vijayprasath, & Rajan, 2015). Momentum optimizations can be done by using layout components (parameterized) from the schematic page. While an overall performance of high frequency circuit boards, antennas and integrated circuits prediction of the entire tool in momentum (Rajan, 2015). Momentum has a 3-dimensional interface that it presents to the user in the course of simulations and results (Rajan, 2014). It is a 2.5D solver that can do both 2D and 3D computations. The directivity and the far-field radiation patterns of the antennas are provided both 2D and 3D graphs.

4. APPLICATION OF MOMENTUM

ADS Momentum can be used as follows (Ramli et al., 2012).

- ADS Momentum is applicable when no analytical model exists for the circuit. Momentum co-simulates, with ADS and performs the required tasks and it can be used to determine coupling effects.
- ADS Momentum can calculate narrow resonances within the circuit model which cannot be found with analytical models.
- ADS Momentum can be used to display the radiation patterns and far field radiation plots for antennas etc.
- ADS Momentum can show the current pattern and current densities within the circuit.
- Momentum can be used for the CPW (Co Planar Waveguides) results with no slot mode.
- Momentum can be used to optimize or modify the geometry of the passive layouts to achieve the desired results.

5. SIMULATION RESULTS

Design of eight square patch antennas was simulated in ADS. While using for ADS, RF antennas are very well simulated. After simulation, the design of the proposed antenna is as follows. The simulated S- parameters can be varied from 68 to 78 GHz as in figure 2.

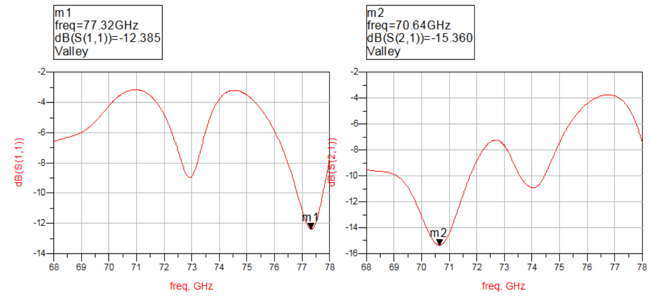

Fig. 2. Simulated reflection coefficient of HG_{11} patch antenna.

A return loss of less than -10dB was achieved at the resonant frequencies 77.32 GHz and 70.64GHz. Design and simulation done in FR4 substrate which has a loss tangent of 0.015.

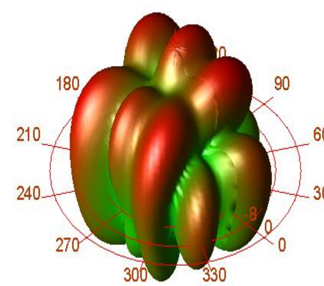

Fig. 3. Radiation Pattern of the microstrip patch antenna.

Radiation pattern and the numerous antenna parameters are displayed in figure 3 and figure 4 respectively. It shows the window for frequency 77.32 GHz and Radiation pattern values to gain, directivity power radiated. Antenna parameters are directivity and gain range maximum equal it denotes the design of the antenna is correctly.

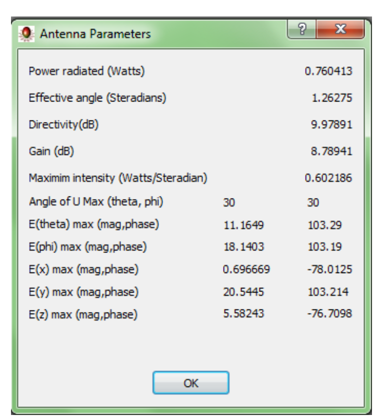

Fig. 4. Window showing parameters of the designed antenna in ADS.

6. RESULTS AND DISCUSSION

Design of microstrip patch antenna has an existing system of contain four patches with single inset feeding technique is used, then result of frequency is 74.24GHz return loss is -21.567dB and overall size of the antenna array is 8 x 8 x 0.125 mm^3. Proposed system have a result of return loss is -12 to -15 dB. The result of return loss only decreased and the gain and directivity results are increased in proposed system. This variation is shown in the below table 2. Microstrip patch antenna used for their application of radar communication and wireless applications.

Table 2. Performance Comparison.

Parameters	Existing System	Proposed System
Return loss	21.567dB	-12 to -15dB
Bandwidth	0.346 GHz	0.107 GHz
VSWR	1.2045	1.158
Gain	8.78941dB	10.8145dB
Directivity	9.97891dB	10.8145dB

7. CONCLUSION

High gain and high directivity was achieved in the simulation of eight square patch arrays. The compact array structure provides better return loss and bandwidth. Because of tiny and less weight and fabrication of this antenna becomes easier. The designed array can be applied to numerous applications in communication system. The requirement of narrowband antenna in various secured communications increasing in current scenario. This antenna can be used for such application.

REFERENCES

Affandi, A. M., Dobaie, A. M., Kasim, N., & Al-Zahrani, N. A., (2015). Rectangular Microstrip Patch Antenna Arrays With Inset for Cellular Phones Application. Journal of Electronic Systems, 5(1), 9-16.

Annakamatchi, M., & Keralshalini, V., (2018). Design of Spiral Shaped Patch Antenna for Bio-Medical Applications. International Journal of Pure and Applied Mathematics, 118(11), 131-135.

Bano, M., Rastogi, D. A., & Sharma, S. (2014). Design and simulation of microstrip patch antenna using different substrates. International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), 3(11), 3871-3875.

Khidre, A., Lee, K. F., Yang, F., & Elsherbeni, A. Z. (2012). Circular polarization reconfigurable wideband E-shaped patch antenna for wireless applications. *IEEE transactions on antennas and propagation*, *61*(2), 960-964.

Mohanapriya, S., & Vadivel, M., (2013). Automatic retrival of MRI brain image using multiqueries system. International Conference on Information Communication and Embedded Systems, 1099-1103,IEEE.

Narendra, B. P. (2013). Micro strip patch antenna design for GPS application using ADS software. *Journal of Information, knowledge and Research in Electronic and Communication Engineering*, *2*(2), 475-478.

Parashar, K. K. (2014). Design and Analysis of I-Slotted Rectangular Microstrip Patch Antenna for Wireless Application. *International Journal of Electrical & Computer Engineering (2088-8708)*, *4*(1),31-36.

Rajan S. P., (2014). A Significant and Vital Glance on "Stress and Fitness Monitoring Embedded on a Modern Telematics Platform. Telemedicine and e-Health Journal, 20(8), 757-758.

Rajan S.P., (2015). Review and Investigations on Future Research Directions of Mobile Based Tele care System for Cardiac Surveillance. Journal of Applied Research and Technology, 13(4), 454-460.

Rajan, S. P., & Sukanesh, R., (2013a). Experimental Studies on Intelligent, Wearable and Automated Wireless Mobile Tele-Alert System for Continuous Cardiac Surveillance. Journal of Applied Research and Technology, 11(1), 133-143.

Rajan, SP., Sukanesh, R., (2013b). Viable Investigations and Real Time Recitation of Enhanced ECG Based Cardiac Tele-Monitoring System for Home-Care Applications: A Systematic Evaluation. Telemedicine and e-Health Journal, 19(4), 278-286.

Rajan, S. P., & Davood, K. S., (2015). Performance Evaluation on Automatic Follicles Detection in the Ovary. *International Journal of Applied Engineering* Research, 10(55), 1-5.

Rajan, S. P., & Dinesh T (2015). Systematic Review on Wearable Driver Vigilance System with Future Research Directions. International Journal of Applied Engineering Research, 10(1), 627- 632.

Rajan, S. P., & Kavitha, V. (2017). Diagnosis of cardiovascular diseases using retinal images through vessel segmentation graph. *Current Medical Imaging Reviews*, *13*(4), 454-459.

Rajan, S. P., & Kavitha, V. (2017). Diagnosis of cardiovascular diseases using retinal images through vessel segmentation graph. *Current Medical Imaging Reviews*, *13*(4), 454-459.

Rajan, S. P., & Vivek, C., (2019). Analysis and design of microstrip patch antenna for radar communication. Journal of Electrical Engineering and Technology, 14(2), 923-929.

Ramli, N., Ali, M. T., Yusof, A. L., Pasya, I., Alias, H., & Sulaiman, M. A. (2012). A frequency reconfigurable stacked patch microstrip antenna (FRSPMA) with aperture coupler technique. In *2012 IEEE Symposium on Wireless Technology and Applications (ISWTA)* (pp. 266-271).

Rajan, S. P., & Vivek, C., (2019). Analysis and design of microstrip patch antenna for radar communication. Journal of Electrical Engineering and Technology, 14(2), 923-929.

Saxena, D., Agarwal, S., & Srivastava, S. (2014). Low Cost E-Shaped Microstrip Patch AntennaArray for WLAN. International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering,3(4),8831-8837.

Siddique, O., Kamran, M., Ahmad, W., Alshomrani, S., Din, I., & Akram, S. (2013). Design and simulation of microstrip phase array antenna using circular patches. *Int J Appl Inf Syst*, *6*(5), 5-10.

Singh, R. B., & Agarwal, E. N. (2015). Design and Analysis of Circle Head Shape Microstrip Patch Antenna. International Research Journal of Engineering and Technology (IRJET), 2(2), 1-17.

Singhal, P. K., Bimal Garg. (2012). Design and Characterization of Compact Microstrip Patch Antenna Using Split Ring Shaped Metamaterial Structure. International Journal of Electrical and Computer Engineering, 2(5), 655-662.

Sukanesh, R., Gautham, P., Rajan, S P., & Vijayprasath, S., (2010). Cellular Phone based Biomedical System for Health Care. IEEE Digital Library Xplore: 550-553.

Vijayprasath, S., & Rajan, S. P. (2015). Performance investigation of an implicit instrumentation tool for deadened patients using common eye developments as a paradigm. International Journal of Applied Engineering Research, ISSN, (0973-4562), 925-929.

Vivek, C., & Rajan, S. P., (2016). Z-TCAM. An Efficient Memory Architecture Based TCAM. Asian Journal of Information Technology, 15(3), 448-454.

Yao, H., Kumar, H., Ei, T., Ashrafi, N., Ashrafi, S., MacFarlane, D. L., & Henderson, R. (2016). Patch antenna array for the generation of millimeter-wave Hermite–Gaussian beams. IEEE Antennas and Wireless Propagation Letters, 15, 1947-1950.

Rajan, S. P., & Kavitha, V. (2017). Diagnosis of cardiovascular diseases using retinal images through vessel segmentation graph. *Current Medical Imaging Reviews*, *13*(4), 454-459.

Rajan, S. P., & Vivek, C., (2019). Analysis and design of microstrip patch antenna for radar communication. Journal of Electrical Engineering and Technology, 14(2), 923-929.

Ramli, N., Ali, M. T., Yusof, A. L., Pasya, I., Alias, H., & Sulaiman, M. A. (2012). A frequency reconfigurable stacked patch microstrip antenna (FRSPMA) with aperture coupler technique. In *2012 IEEE Symposium on Wireless Technology and Applications (ISWTA)* (pp. 266-271).