IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p-ISSN: 2278-8735
PP 30-35
www.iosrjournals.org

An Array Antenna Design for Cognitive Science Application That Tune At 2.45ghz With Better Gain And Directivity

Pavithraasree Kirubakaran[1], Dr.M.Shanmuga Priya[2]
[1](Electronics and Communication Engineering, M.A.M.college of Engineering, India)
[2](Electronics and Communication Engineering, M.A.M.college of Engineering, India)

Abstract: *This paper refers to a detailed analysis of the design and implementation of a 4x1 microstrip patch antenna array of given specifications using HFSS software and a dielectric material FR4 with dielectric substrate permittivity of 4, height of 1.6 mm. The microstrip patch antenna array is designed for Cognitive Science applications, at an operating frequency of 2.45 GHz with microstrip line feed. The designed antenna had a minimum return loss of about -12dB for 1.6mm height and gain with 5dB. The achievement of narrowband width for cognitive science application. Microstrip patch antennas has high directional pattern with increased efficiency and suppresses unwanted interference and emissions on other side. Cognitive antennas are effectively used in industrial, scientific and medical applications at 2.45GHz. This antenna has the characteristics of providing multiband applications also.*

Keywords: *Microstrip Antenna; Antenna Arrays; Antenna; Simulation; Microstrip Line Feed, Cognitive Science.*

I. Introduction

As an interface between the transmitter/receiver and the propagation media, antenna is an essential part of any wireless communication (satellites, radars, aviation, medical applications, ground penetrating radar etc.).[1] [2] [3] The key features of a microstrip patch antenna are ease of construction, light weight, low cost, the antenna can take an arbitrary form of the space that occupies if the substrate is flexible and the production process has a highly level of integration, the same circuit can include the microstrip antenna and also the feeds [3] . These advantages of microstrip antennas make them popular in many wireless communication applications such as telemetry and communications, aviation, naval communications, automatic guidance of intelligent weaponry, radar, GPS systems. The disadvantages of microstrip patch antennas are: narrow frequency band with low efficiency, feeds have high losses and disability to operate at high power levels of waveguide [3] [4]. Therefore, reliable solutions must be found to increase bandwidth and to achieve higher gain. The history of the wireless communication started with the discovery of a coherent which is an original detection device for the detection of electromagnetic waves in long-wave frequency band. Recently, mobile devices are developed rapidly for transferring data, voice, image, and video due to user demands for high quality communication [5]. Study on electromagnetic spectrum usage in microwave bands was done where available spectrum is about 15-85% [6]. Therefore, effective electromagnetic spectrum usage is studied and developed. microstrip-line feed is easy to fabricate, simple to match by controlling the inset position and rather simple to model [7]. design and performance analysis of microstrip array antenna [8],is discussed in this paper

I.1 Cognitive radio

Cognitive radio is an adaptive intelligent Radio Technology that can automatically detect available channels in wireless network it will change transmission parameters enabling more Communications to work simultaneously cognitive radio is based on software defined radio it provides additional flexibility and offer more efficiency to use the overall spectrum the main idea of cognitive radio if two utilize the radio spectrum more effectively it is possible to develop a radio that is able to look at the spectrum to detect which frequencies are clear. Cognitive radio is a one method to realize effective and efficient spectrum usage. It use Dynamic Spectrum Access (DSA) where users can use unused licensed spectrum from the primary users [13,14]. One of the key component for realizing the cognitive radio is antenna for transmitting and receiving data in communication and for sensing to identify spectrum condition [15].characteristics of cognitive radio is cognitive capability it is used to identify the unused spectrum at a specific time or location another is reconfigurability a cognitive radio can be programmed to transmit and receive on a variety of frequencies .Technologies supported by its hardware design the emerging applications of cognitive radio is on military application multimedia cellular system.

II. Antenna Design

In this paper, the microstrip patch antenna array (4x1) has been designed to operate at a center frequency of 2.4 GHz with an input impedance of 50 Ω using a dielectric material FR4, tangent loss tgδ=0.002 and thickness (h) of 1.6 mm. For microstrip antennas, the dielectric constants are usually in the range of $2.2<E_r<12$. The most popular models for the analysis of microstrip patch antennas are the transmission line model, cavity model and full wave model. The transmission line model is the simplest of all and it gives good physical insight but it is less accurate.

The width of the microstrip patch antenna was computed with the following equation.

where c is the speed of light (3x108 m/s), fr is the operating frequency of 2.4 GHz and εr is the dielectric permittivity

The transmission line model is used and following steps are followed to design the antenna

1.Width calculation (W)

$$W = \frac{1}{2fr\sqrt{\mu o \varepsilon o}}\sqrt{\frac{2}{\varepsilon r + 1}}$$

Substituting εr = 4.4 and fo = 2.4 GHz, we get: W = 0.03803 m = 38.03 mm

2.Effective dielectric constant calculation (εreff)

$$\varepsilon reff = \frac{\varepsilon r + 1}{2} + \frac{\varepsilon r - 1}{2}\left(1 + 12\frac{h}{w}\right) - 1/2$$

Substituting :εr= 4.4, W = 38.03 mm and h = 1.6 mm, we get : εreff = 4.3996

3.Effective length calculation (Leff)

$$Leff = \frac{c}{2fr\sqrt{\varepsilon reff}}$$

Leff=0.028569 m = 28.569mm

4. Length extension calculation (L)

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon reff + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon reff - 0.258)(\frac{W}{h} + 0.8)}$$

Substituting :εreff=4.3996 , W = 38.03 mm andh =1.6 mm we get L =49

5. Actual length of patch calculation (L)

$$L = Leff - 2\Delta L$$

III. Antenna Design 1 For Cognitive Science Application

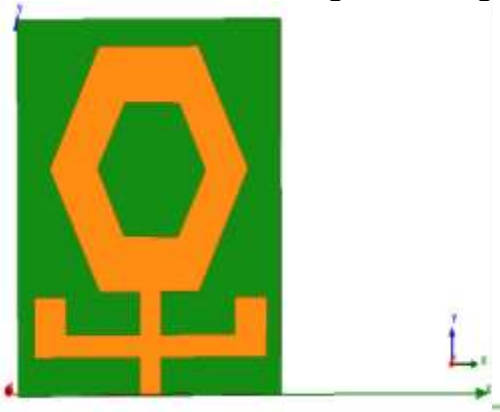

Fig 1: Microstrip Patch Antenna

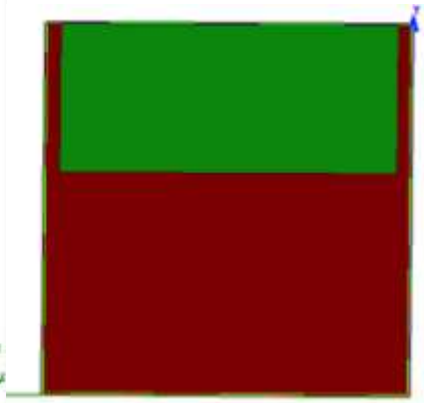

Fig 2: Ground Structure

Figure 1 shows the basic structure of the polygonal patch antenna. It is structured with planar structure. On the top side, the antenna is composed of an polygonal patch, arms, and feeding. The arm was modified from T-shape monopole arms for improving operational bandwidth [9]. Length of the arm is set to a half wavelength

of the designed center frequency. Figure 2 shows The U-shape ground plane can be used improving matching condition [10].The polygonal shape contributes for enhancing efficiency of antenna radiation. A radiation efficiency value of antenna will affect to the antenna gain [11] .The patch antenna was analyzed in detail using HFSS software. In calculation, antenna characteristics such as return loss, Voltage-Standing- Wave- ratio (VSWR), radiation pattern, and gain can be obtained.

Based on the designed parameters in The calculated return loss of the designed antenna is shown in Fig.3. We can see that the operational frequency of the designed antenna is 2.45GHz with the return loss of -20dB. Based on this result, the antenna can be used for several application in wireless communication.

III.1.Simulation Results of Antenna Design 1

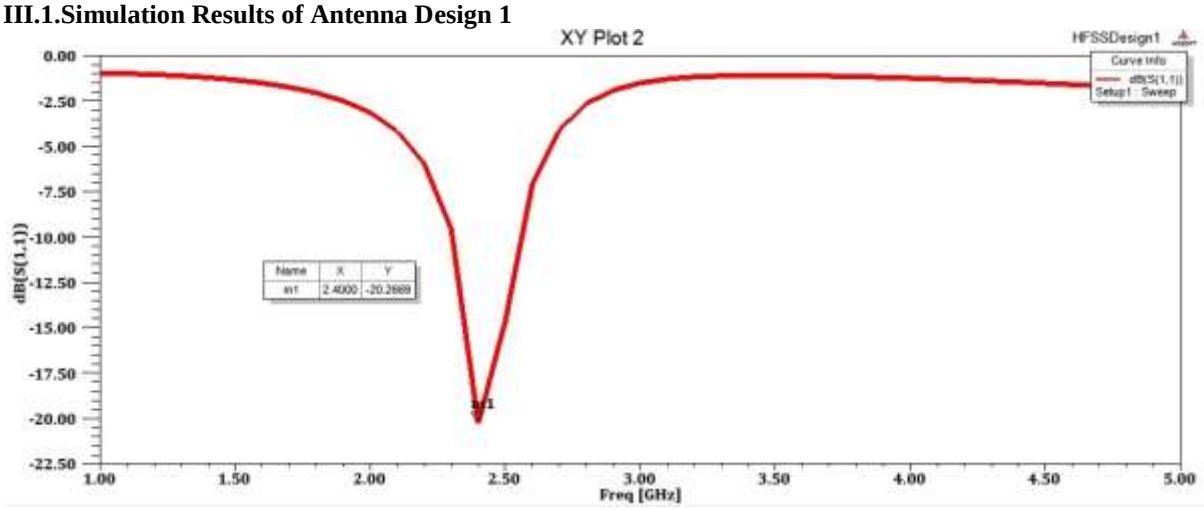

Fig 3:Return loss of Patch Antenna

Figure 4 shows the calculated VSWR of the designed patch antenna. In operational frequency of 2.45GHz, the VSWR of below 1.2 were obtained. Based on this results, we believe that the antenna has good efficiency for radiating or receiving microwave signal.

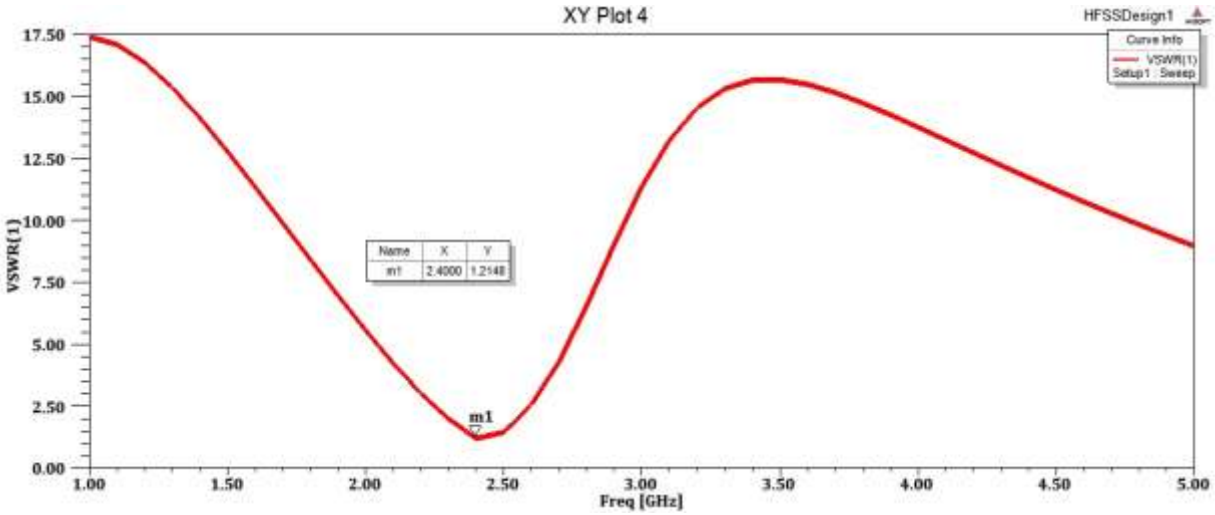

Fig 4: VSWR of Patch Antenna

Figure 5 shows the calculated gain of the designed antenna. The calculated gain is relatively low (below 0dB). The antenna gain can be enhanced for several times using array structure depends on the number of the antenna in array structure [12].

Figure 6 shows the radiation pattern operational frequency in common applications. The calculated radiation pattern at 2.45GHz is shown. We can see that in general the designed antenna has quite good radiation patterns.

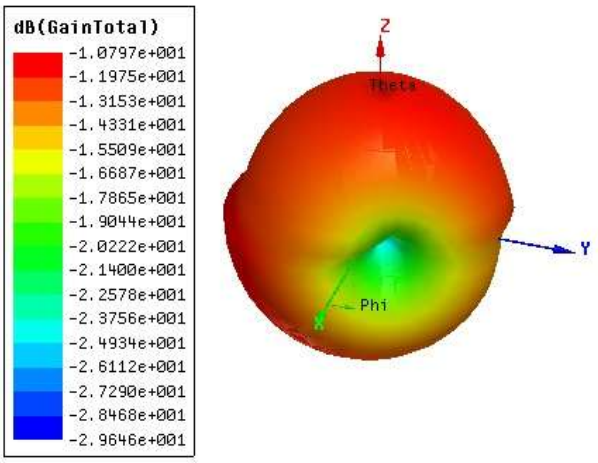

Fig 5: Gain of Patch Antenna

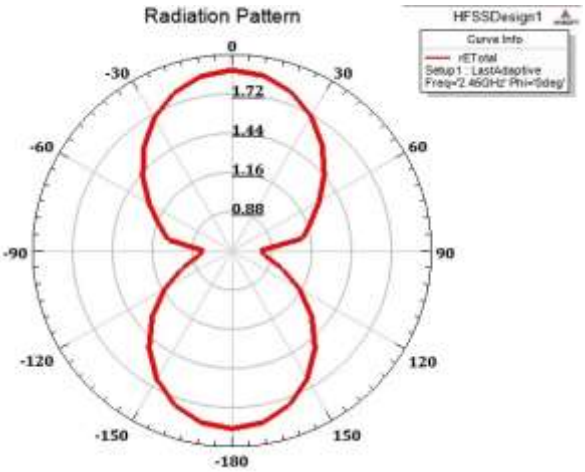

Fig 6: Radiation Pattern of Patch Antenna

IV. Proposed Antenna Design For Cognitive Science Application

The basic structure of the proposed array antenna. Figure 7 On the top side, the antenna is composed of an polygonal patch, arms, and feeding with an array concept in order to increase the gain of the array antenna .The patch antenna was analyzed in detail using HFSS software. In calculation, antenna characteristics such as return loss, Voltage-Standing- Wave- ratio (VSWR), radiation pattern, and gain can be obtained.

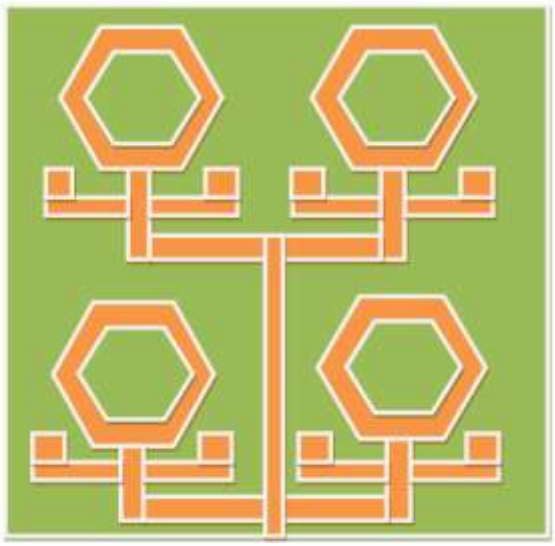

Fig 7: Proposed Array Antenna

IV.1.Simulation Results of Proposed Antenna Design for Cognitive Science Application

Based on the designed parameters in the calculated return loss of the designed array antenna is shown in Fig.8. the operational frequency of the designed antenna is 2.45GHz with the return loss of below -12dB. This is the frequency range wherein the structure has a usable bandwidth compared to a certain impedance, usually 50 Ω. The plot below shows the return loss of a patch antenna and indicates the return loss bandwidth at the desired (S11/VSWR). the antenna can be used for several application in wireless communication such as in military application , genetic engineering, networking, cognitive science.

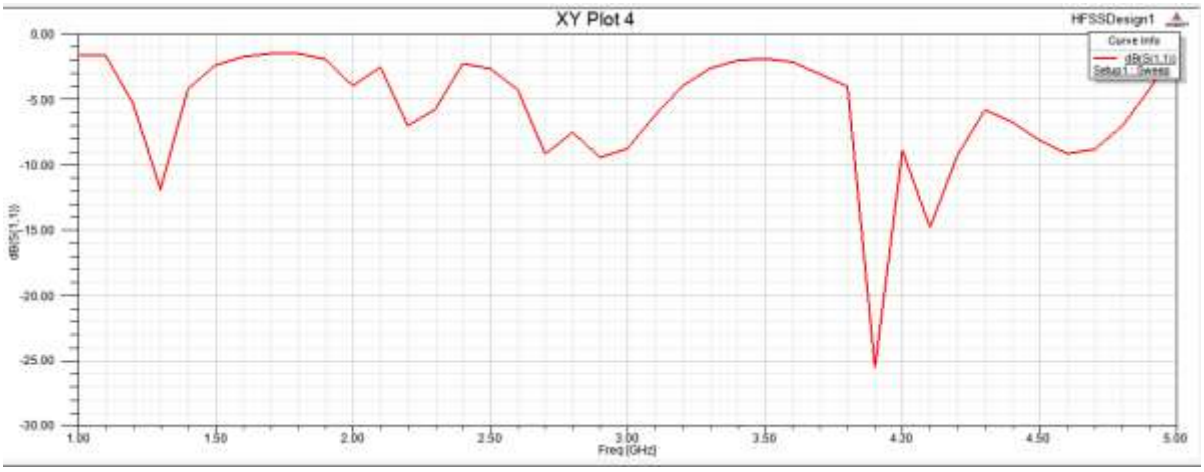

Fig 8: Return loss of Array Antenna

Figure 9 This radiation pattern shows the antenna radiates more power in certain direction than the other direction the antenna is set to have certain their activity directivity it is commonly expressed in dB. The calculated radiation pattern at 2.45GHz is shown.

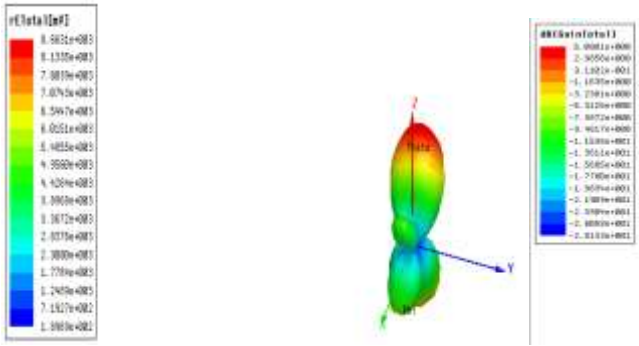

Fig 9: Radiation Pattern of Array Antenna

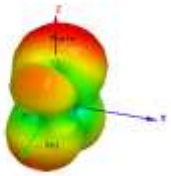

Fig 10: Gain of Array Antenna

Figure 10 shows the calculated gain of the designed antenna. The calculated gain is relatively high of 5dB. The ability of the antenna to concentrate the radiated power in give one direction. Antenna gain can also be specified using the total efficiency instead of the radiation efficiency only. Here the gain of the antenna is increased by the use of array structure it can also be improved by adding further arrays. higher the gain of the antenna the directivity will be increased.the calculated VSWR for the designed antenna is relatively low. The mismatched impedance causes some of the power to be reflected back toward the source. reflections cause destructive interference, leading to peak in voltage. VSWR measures the variance in voltage

V. Conclusion

A microstrip array antenna with micro strip feed line has been designed and simulated. The performance of the antenna were tested the parameters shows that the array antenna out perform the single antenna in terms of Return loss, directivity, bandwidth and gain. The final array antenna with dimension in design FR4 substrate using HFSS software. Overall, the performance of the array antenna meets the desired requirement in terms of return loss, gain radiation pattern , VSWR. The simulated return loss is equal to -12 dB ,VSWR is relatively low with the center frequency of 2.45GHz and the gain of 5dB.therefore the application of this paper will be use full for cognitive science. Cognitive antennas are effectively used in military, industrial, scientific and medical applications

References

[1]. Priya Upadhyay, Vivek Sharma, Richa Sharma, Design of Microstrip Patch Antenna Array for WLAN Application, IJEIT, Volume 2, Issue 1, July 2012.

[2]. Tanvir Ishtaique-ul Huque, Kamal Hosain, Shihabul Islam, Al-Amin Chowdhury, Design and Performance Analysis with Optimum Param. For X-band Apps, IJACSA, Vol. 2, No. 4, 2011.

[3]. Koen W.A. van Dongen, Peter M. van den Berg, and Ioan Nicolaescu, ``Subsurface imaging using measured near-field antenna footprints", Near Surface Geophysics, February 2004, Vol. 2, Number 1, pp. 31-37, ISSN: 1569-4445,

[4]. Naresh Kumar Poonia, Krishan Kumar Sherdia, Microstrip Antenna Array for WiMAX & WLAN Applications, IJARCCE, Vol. 2, Issue 9, September 2013.

[5]. M. Akter, M. B. I. Reaz, F. Mohd-Yasin, and F. Choong, "Hardware Implementations of an Image Compressor for Mobile Communications", Journal of Communications Technology and Electronics, 2008, Vol. 53, No. 8, pp. 899–910.
[6]. FCC, Spectrum Policy Task Force Report, ET Docket No. 02-155, Nov02, 2002.
[7]. Garg, R., P. Bhartia, I. Bahl and A. Ittipiboon, "Microstrip Antenna Design Handbook", Artech House, Inc, 2001.
[8]. M. Mahfuzul Alam, Md. Mustafizur Rahman and Md. Osman Goni, "Design and performance analysis of microstrip array antenna", Progress In Electromagnetics Research Symposium Proceedings, Moscow, Russia, August, 2009.
[9]. K.L.Wong, and Y.F.Lin, "Microstrip Line fed Compact Microstrip Antenna with Broadband Operation," IEEE Antenna and Propagation Symp. Digest, 1998, pp.1120-1123.
[10]. Roy B. V. B. Simorangkir, "Antena Mikrostrip UWB kompak 50 - 5000MHz untuk Aplikasi SFCW GPR", Tugas Akhir ITB, 2010.
[11]. Binu Paul, S.Mridula, C.K.Aanandan, K.Vasudevan, P.Mohanan, "Octagonal Microstrip Patch Antenna For Dual Band Applications", Proceedings of the XXVIIIth URSI General Assembly, New Delhi, October 2005
[12]. John D. Kraus, Antennas for All Appilcation 3nd Edition, New delhi : Tata MC Graw-Hill Publishing Company Limited, 2003.
[13]. N. Armi, M. Wahab, A. Y. Hercuadi "Performance Evaluation of Energy Detector in Cooperative Spectrum Sensing", Proceedings of International Conference on Telecommunication Systems Services and Applications, 2014.
[14]. Agus Subekti, Sugihartono, Nana Rachmana S, Andriyan B.Suksmono, A Cognitive Radio Spectrum Sensing Algorithm to Improve Energy Detection at Low SNR, TELKOMNIKA, Vol.12, No.3, September 2014, pp. 717~724.
[15]. John D. Kraus, Antennas for All Appilcation 3nd Edition, *New delhi : Tata MC Graw-Hill Publishing Company Limited*, 2003.