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ELLIPTICAL PATCH MICROSTRIP ANTENNA FOR BLUETOOTH/WI-FI APPLICATIONS

BLUETOOTH VE Wİ-Fİ UYGULAMALARI İÇİN ELİPTİK YAMA MİKROŞERİT ANTEN TASARIMI

Hilal KURT[1], Adnan KAYA[2]

[1,2] Department of the Electrical and Electronics Engineering/ Izmir Katip Celebi University, Turkey

ABSTRACT

In the wireless communication applications, widespread usage of microstrip patch antennas due to their advantages such as compactness, easy fabrication and low cost, is pushed forward researchers to develop desired antennas or improve the existing antennas to get desired one. But it is challenging to get desired antennas since microstrip patch antennas have some disadvantages such as low gain and narrow bandwidth. In this work, elliptical patch microstrip antenna is designed for Bluetooth/Wi-Fi applications. The antenna is designed in the form of slotted elliptical patch and defected ground structure method. Defected ground structure method is applied by using rectangular slots with different dimensions in this work. The proposed antenna is modelled using CST MWS software. Return loss, gain and directivity values are -16.45 dB, 1.82 dBi, and 5.81 dBi at 2.45 GHz, respectively. On the other hand, maximum directivity and gain values are 5.86 dBi and 2.06 dBi at 2.4 GHz, respectively. The bandwidth is 63.1 MHz (2.41 GHz – 2.48 GHz) at 2.45 GHz. According to the results, IEEE 802.11 b/g standards are supported by the designed antenna. So, it can be used for Bluetooth and Wi-Fi applications at 2.4 GHz.

Keywords: Patch Antenna, Bluetooth, Wi-Fi, IEEE 802.11b/g, 2.4 GHz antenna design

1. INTRODUCTION

In recent years, microstrip patch antennas are widely used in several wireless applications, due to their advantages such as low profile, ease of manufacture, low cost, light weight, compactness etc. (Mabaso and Kumar, 2018; Markina, et al., 2018). On the other hand, the microstrip antennas also have various disadvantages such as low gain and narrow bandwidth (Atas, et al., 2020). Researchers try to overcome the inherent technical problems by changing the geometry of patches (e.g. square, rectangular, elliptical, triangle, circular etc.), applying several feeding methods, using slots and so on (Kocer and Aydemir, 2020; Markina, et al., 2018). Rapid development of microwave and and millimeter wave component technology necessitates, the replacement of existing wireless components (Palandoken, et al., 2012;Rymanov, et al., 2012;Montero-de-Paz, 2013; Palandoken and Ucar, 2014; Palandoken and Sondas, 2014). In literature, there are several works on microstrip patch antennas. Some of them can be summarized as follows, M. Mabaso and P. Kumar designed and developed dual band microstrip patch antenna. The antenna operates at 2.4 GHz and 5.8 GHz. Defected Ground Structure (DGS) method is used in the antenna. The antenna consists of a rectangular patch and ground with two rectangular slots and an elliptical slot. An elliptical slot is used to enhance the bandwidth and two rectangular slots are used to drive the antenna in the dual mode. Maximum directivities can be given as 5.1 dBi and 7.9 dBi for 2.4 GHz and 5.8 GHz respectively. Maximum gains can be given as 4.3 dBi and 7.4 dBi for 2.4 GHz and 5.8 GHz respectively (Mabaso and Kumar, 2018). Busra Gungorer, Mustafa Tekbas and Ahmet Kayabasi studied on the effect of feeding type on the performance of the antenna using two different antennas with different dimensions.

As a result of that work, it is observed that, according to the parameters of the antenna, coaxial feeding is better than microstrip line feeding (Kayabasi, et al., 2019). Petrus Kerowe Goran and Eka Setia Nugraha proposed a square patch microstrip antenna with a slit method. The antenna operates at 2.4 GHz and 5 GHz frequencies. Return loss values with asymmetric slit method can be given as -10.15 dB and -37.32 dB for 2.4 GHz and 5 GHz respectively (Goran and Nugraha, 2020). G. Geetharamani and T. Aathmanesan developed a patch antenna with novel radiating structure that operates at 2.4 GHz frequency. Return loss of the antenna is -17.29 dB. Bandwidth and gain values of the antenna can be given as 130 MHz and 3.93 dBi, respectively (Geetharamani and Aathmanesan, 2019). Rezvani and Zehforoosh designed multiband microstrip antenna. Since the proposed antenna covers 3.4 GHz, 4.3 GHz, 5.2 GHz and 5.8 GHz frequency bands, the antenna can be used for wireless local area network (WLAN) and Worldwide Interoperability for Microwave Access (WiMAX) applications (Rezvani and Zehforoosh, 2017). R. S. Uqaili, J. A. Uqaili, S. Zahra, F. B. Soomro and A. Akbar designed dual band rectangular patch microstrip antenna. The antenna operates at 2.5 GHz and 5.8 GHz resonance frequencies and their bandwidths are 100 MHz (2.5 GHz - 2.6 GHz) and 200 MHz (5.7 GHz - 5.9 GHz), respectively. Return loss parameters can be given as -29.9 and -15.16 for 2.5 GHz and 5.8 GHz respectively. VSWR parameters are

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less than 1.5 for both frequencies. Gain values are 1.37 dBi for 2.5 GHz and 3.9 dBi for 5.8 GHz (Uqaili, et al., 2020). S. Bayer Keskin, C. Guler, R. B. Aymaz, G. S. Gursoy and E. Ozbey. Developed a microstrip antenna that operates at 2.4 GHz resonance frequency. Its bandwidth is 301 MHz. Gain of the antenna is 2.97 dBi (Bayer Keskin, 2019). O. M. Adegoke and I. Eltoum designed 2.4 GHz rectangular shaped microstrip patch antenna. The return loss of the antenna can be given as -29.7 dB. VSWR value is 1.2 (Adegoke and Eltoum, 2019). V. R. Gupta and N. Gupta proposed two low profile microstrip patch antenna. The antennas operate at 2.4 GHz frequency band. The antennas and a simple square patch antenna are compared in the study (Gupta and Gupta, 2006). E. Aravindraj and K. Ayyappan designed slotted H-shaped microstrip patch antenna with dumbbell (H) shaped Defective Ground Surface. The antenna operates at 2.4 GHz with 129 MHz bandwidth (2.37 GHz - 2.50 GHz). Gain is 8.96 dBi and return loss is -29.02 dB (Aravindraj and Ayyappan, 2017). Basaran developed compact dual band printed antenna for 2.4/5.2 GHz WLAN applications (Basaran, 2021). S. Murmu and I. Misra designed V shaped microstrip patch antenna that operates at 2.4 GHz frequency band. The antenna was fed with coaxial feeding method. Bandwidth of the antenna is 50 MHz (Murmu and Misra, 2011).

The remaining part of the presented paper is organized as follows, antenna geometry and materials that is used to design antenna are given in Section II. Simulation results of the proposed antenna are given in Section III. The antenna is compared with several antennas in the literature in Section IV and the results of the study is summarized in Section V.

2. MATERIAL AND METHOD

In this study, a simple circular patch microstrip antenna has been designed with defected ground structure. Defected ground structure is applied by using rectangular slots with different lengths. Patch is designed in the form of elliptical slotted elliptical patch. Microstrip line feeding technique with discrete port is used to feed the antenna. In Figure 1 and Table 1, geometrical values of the antenna are given. FR-4 is used in the antenna as substrate substrate material of thickness 1.6 mm. Also annealed copper is used as ground and patch materials with 0.035 mm thickness.

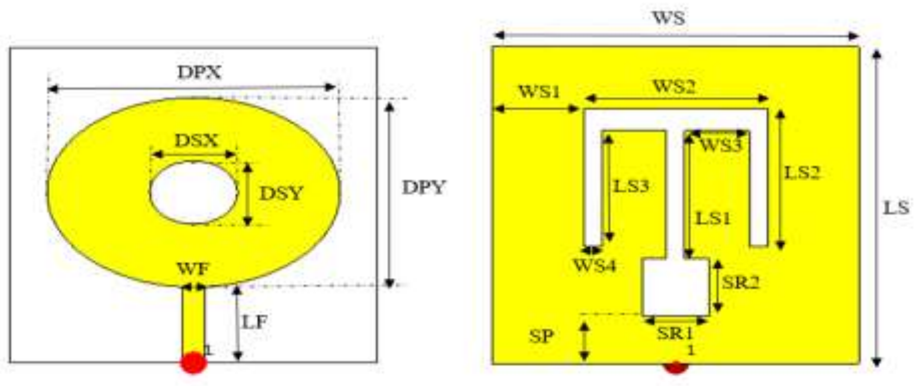

Figure 1: Geometrical Parameters of the Proposed Antenna

Table 1: Geometrical Values of the Proposed Antenna (mm)

DPX	40	LS	50
DPY	30	LS1	20.25
DSX	12	LS2	21.75
DSY	10	LS3	18.25
WF	3	SR1	9.00
LF	12.04	SR2	9.00
WS	50	SP	7.50
WS1	12.50	WS3	8.75
WS2	25	WS4	2.50
Center of the elliptical slot (x, y)	(0, 2)	Center of the elliptical patch (x, y)	(0, 2)

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Table 2: Antenna Resonance Frequency Parameters

Resonance Frequency	S1,1 (dB)	Gain (dBi)	Directivity (dBi)
2.45 GHz	-16.45	1.82	5.81

3. FINDINGS

According to the simulation results, the antenna resonant frequency is 2.45 GHz. Return loss and gain values are -16.45 and 1.82 dBi at 2.45 GHz respectively. The bandwidth of the antenna is 63.1 MHz (2.41 GHz – 2.48 GHz). VSWR value of the antenna is 1.35. S_{11} graph of the antenna is given in Figure 2. Also, farfield radiation pattern is given in Figure 3. According to the simulation results, maximum gain is 2.06 dBi and maximum directivity is 5.86 dBi at 2.4 GHz.

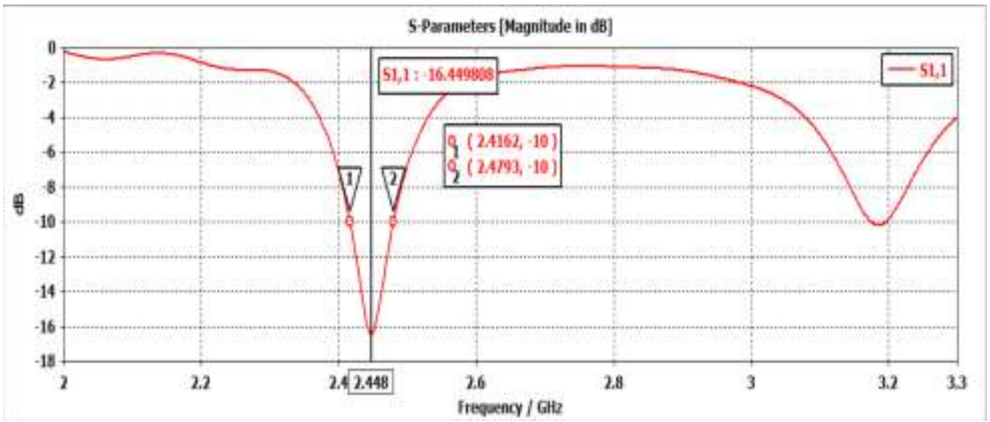

Figure 2: S11 Graph of the Antenna

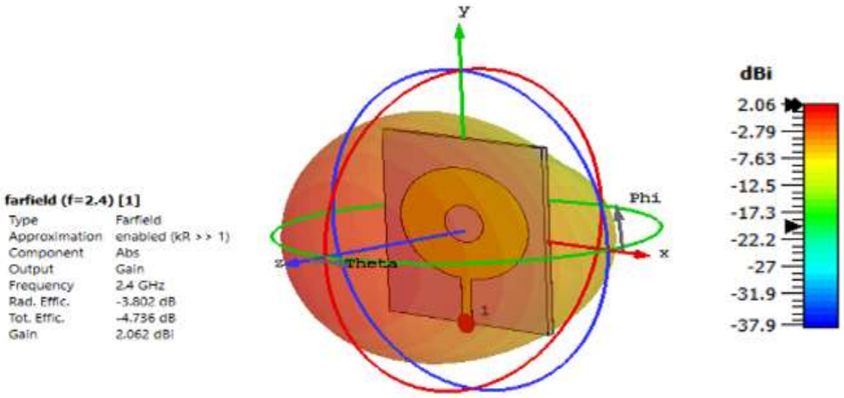

Figure 3: Simulated 3D radiation pattern of the proposed antenna

4. RESULT AND DISCUSSION

Designed elliptical patch microstrip antenna has appropriate gain and frequency band for Bluetooth and 2.4 GHz Wi-Fi applications. The simple structured, small size elliptical patch microstrip antenna can be integrated easily projects related to Wi-Fi and Bluetooth applications.

Table 3: Comparison of Antennas

Reference	Frequency (GHz)	Gain (dBi)
[14]	2.5 5.8	1.37 3.9
[21]	2.44 5.25	0.5 5
This work	2.4	2.06

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5. CONCLUSION

In this paper, elliptical patch microstrip antenna is designed to use Bluetooth/Wi-Fi applications. The antenna structure is simple and its size is appropriate according to the antennas in the literature. According to the results, maximum gain and directivity can be given as 2.06 dBi and 5.86 dBi, respectively. Also, IEEE 802.11b/g standards are supported by the designed antenna, so, it can be used for Bluetooth and 2.4 GHz Wi-Fi applications.

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