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TRIBAND MICROSTRIP RECTANGULAR PATCH ANTENNA FOR BLUETOOTH/WIFI APPLICATIONS

BLUETOOTH VE WI-FI UYGULAMALARI IÇIN DIKDÖRTGEN YAMA MIKROŞERIT ANTEN TASARIMI

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ABSTRACT

In recent years, according to the requirements of wireless applications, multiband and low profile patch antennas are desired. In this study, a simple rectangular patch triband microstrip antenna is developed to use for Bluetooth/WiFi applications. The antenna is in the form of rectangular slots with different lengths loaded on the rectangular patch with reduced ground size. FR-4 substrate with 1.6 mm thickness is used as substrate material and annealed copper is used as ground and patch materials. The designed antenna is simulated using CST MWS software program. Microstrip line feeding technique with discrete port is used to feed the antenna. According to the results, S11 parameters of three resonant frequencies can be given as -15.08 dB, -11.88 dB and -24.03 dB at 2.39 GHz, 3.07 GHz and 4.92 GHz respectively. Gain values of the resonance frequencies can be given as follows, 2.25 dBi, 3.76 dBi and 1.92 dBi at 2.39 GHz, 3.07 GHz and 4.92 GHz respectively. Proposed antenna bandwidth can be given as, 197.5 MHz (2.29 GHz – 2.49 GHz) at 2.39 GHz, 116.1 MHz (3.01 GHz – 3.13 GHz) at 3.07 GHz and 266.2 MHz (4.79 GHz – 5.06 GHz) at 4.92 GHz, respectively. Since the designed antenna can work at 2.4 GHz and 5 GHz frequency bands with 2.24 dBi and 2.34 dBi, respectively, IEEE 802.11ac/b/g standards are supported by the antenna. So the proposed antenna can be used for Bluetooth and 2.4 GHz/5GHz WiFi applications.

Keywords: Microstrip Patch Antennas, IEEE 802.11ac/b/g, 2.4 GHz, Bluetooth, WiFi

1. INTRODUCTION

In the last decade, due to the rapid development of microwave and millimeter wave component technology, existing wireless components have been replaced with new wireless structures in order to keep up with developing new technological breakthroughs (Palandoken, et al., 2012;Rymanov, et al., 2012;Montero-de-Paz, 2013; Palandoken and Ucar, 2014; Palandoken and Sondas, 2014). Mostly, low profile and multiband wireless structures such as microstrip patch antennas are preferred in wireless applications (Armagan and Kahriman, 2016). Microstrip patch antennas are low profile, easily manufactured, low cost and compact structures (Mabaso and Kumar, 2018; Markina, et al., 2018). However, there are also some disadvantages of microstrip patch antennas. Narrow bandwidth and low gain can be given as examples of the disadvantages of the microstrip patch antennas (Atas, et al., 2020). Some of techniques such as Defected Ground Structure (DGS), loading slots on the patch, changing the shape of the patch, usage of different feeding techniques are used to develop desired antennas by researchers (Kocer and Aydemir, 2020; Markina, et al., 2018). To examine developed antennas, especially in recent years, literature is reviewed. Literature review can be summarized as follows, two low profile microstrip patch antennas are proposed by V. R. Gupta and N. Gupta. The two antennas those are worked at 2.4 GHz are compared with a simple square patch antenna in the work (Gupta and Gupta, 2006). V shaped microstrip patch antenna that operates at 2.4 GHz is designed by S. Murmu and I. Misra. Coaxial feeding method was used to feed the antenna. Bandwidth of the antenna can be given as 50 MHz (Murmu and Misra, 2011).

A rectangular microstrip patch antenna that operates at 2.4 GHz is designed by O. M. Adegoke and I. Eltoum. Return loss and VSWR values of the antenna can be given as -29.69 dB and 1.2, respectively (Adegoke and Eltoum, 2014). H-shaped microstrip patch antenna with slotted dumbbell (H) shaped DGS that operates at 2.4 GHz with 129 MHz bandwidth is developed by E. Aravindraj and K. Ayyappan. Gain and S11 values can be given as 8.96 dBi and -29.02 dB, respectively (Aravindraj and Ayyappan, 2017). A multiband microstrip antenna is proposed by M. Rezvani and Y. Zehforoosh. 3.4 GHz, 4.3 GHz, 5.2 GHz and 5.8 GHz frequency bands are covered by the designed antenna (Rezvani and Zehforoosh, 2017). A dual band microstrip patch antenna that operates at 2.4 GHz and 5.8 GHz is designed by M. Mabaso and P. Kumar. DGS method was used on the ground of the antenna by using two rectangular slots and an elliptical slot to develop dual band antenna and enhance the bandwidth, respectively. Maximum gain and directivity values of 2.4 GHz can be given as 4.3 dBi and 5.1 dBi, respectively. On the other hand, 7.9 dBi and 7.4 dBi values are maximum directivity and gain values of 5.8 GHz (Mabaso and Kumar, 2018). Affect of feeding type on the performance of the antenna is worked by B. Gungorer,

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M. Tekbas, and A. Kayabasi using two different antennas with different dimensions. According to the results, coaxial feeding is better than microstrip line feeding (Kayabasi, et al., 2019). A patch antenna with novel radiating structure that operates at 2.4 GHz frequency is developed by G. Geetharamani and T. Aathmanesan. S11, bandwidth and gain values can be given as -17.29 dB, 130 MHz and 3.93 dBi, respectively (Geetharamani and Aathmanesan, 2019). A microstrip patch antenna that works at 2.4 GHz resonance frequency is developed by S. Bayer Keskin, C. Guler, R. B. Aymaz, G. S. Gursoy and E. Ozbey. Gain and bandwidth of the antenna are 2.97 dBi and 301 MHz, respectively (Keskin, 2019). A dual band rectangular patch microstrip antenna that works at 2.5 GHz and 5.8 GHz frequency bands is designed by R. S. Uqaili, J. A. Uqaili, S. Zahra, F. B. Soomro and A. Akbar. S11, gain and bandwidth parameters are -29.9, 1.37 dBi and 100 MHz (2.5 GHz – 2.6 GHz) for 2.5 GHz, respectively. On the other hand, S11, gain and bandwidth parameters for 5.8 GHz can be given as -15.16, 3.9 dBi and 200 MHz (5.7 GHz – 5.9 GHz), respectively. VSWR values are less than 1.5 for both frequencies (Uqaili, et al, 2020). A square patch microstrip antenna with asymmetric slit method that works at 2.4 GHz and 5 GHz frequencies is proposed by P. K. Goran and E. S. Nugraha. S11 values are -37.32 dB and -10.15 dB for 5 GHz and 2.4 GHz respectively (Goran and Nugraha, 2020). A compact dual band printed antenna for 2.4/5.2 GHz WLAN applications is developed by S. Basaran (Basaran, 2021).

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 are summarized in Section V.

2. MATERIAL AND METHOD

In this work simple rectangular patch microstrip antenna is designed. The antenna dimension is 50 mm x 60 mm. FR-4 with 4.3 relative permeability is used in the antenna as a substrate with 1.6 mm thickness. Annealed Copper is used as ground and patch materials with 0.035 mm thickness. The geometrical parameters of the patch and antenna are given more detailed in Figure 1 and Table 1.

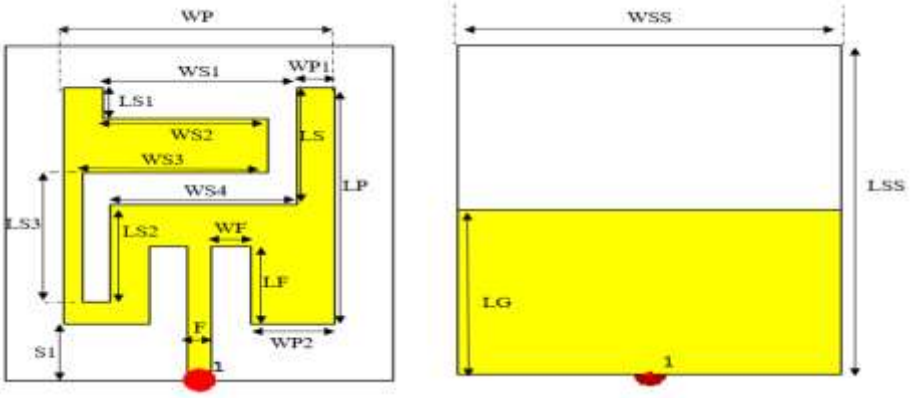

Figure 1: Geometrical Parameters of the Proposed Antenna

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

[1] WSS	[2] 50.00	[3] WS3	[4] 23.75
[5] LSS	[6] 60.00	[7] WS4	[8] 24.00
[9] LG	[10] 30.00	[11] LP	[12] 42.50
[13] WS1	[14] 25.00	[15] LS3	[16] 23.25
[17] WP1	[18] 5.00	[19] LS2	[20] 17.50
[21] WP	[22] 35.00	[23] WF	[24] 5.00
[25] LS1	[26] 5.50	[27] LF	[28] 14.00
[29] WS2	[30] 21.25	[31] F	[32] 3.00
[33] LS	[34] 21	[35] WP2	[36] 11.00
[37] S1		[38] 10.00	

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2.1 Slotted Patch

Antenna patch is loaded with four slots with different lengths to obtain the necessary resonance frequency in the operation band. In the current study, low frequency band is obtained as increasing the slot length LS3.

Table 2: Parameters of Resonance Frequencies

Resonance Frequency	S_{11} (dB)	Gain (dBi)	Directivity (dBi)
2.39 GHz	-15.08	2.25	3.54
3.07 GHz	-11.88	3.76	5.61
4.92 GHz	-24.03	1.92	4.18

3. FINDINGS

Some of the parameters are given in Table 2 for 3 resonance frequencies. According to the results, bandwidths of the antenna can be given as 197.5 MHz (2.29 GHz – 2.49 GHz), 116.1 MHz (3.01 GHz – 3.13 GHz) and 266.2 MHz (4.8 GHz – 5.06 GHz) for 2.38 GHz, 3.07 GHz and 4.91 GHz resonance frequencies respectively. In Figure 2 Figure 3 and Figure 5, S11 graph, farfield radiation pattern at 2.4 GHz and farfield radiation pattern at 5 GHz are given respectively.

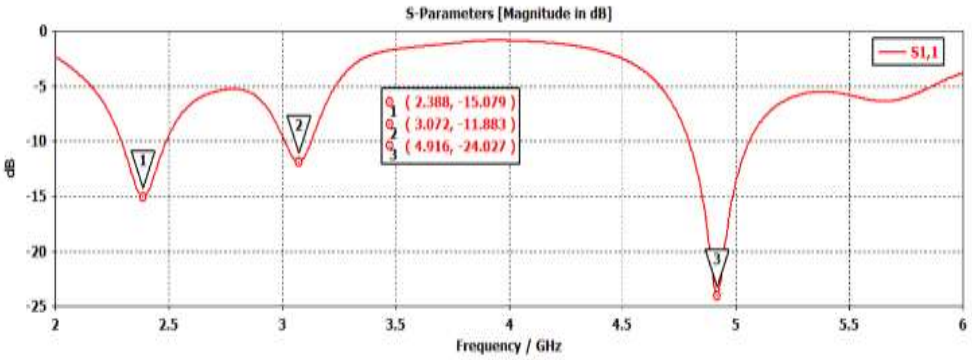

Figure 2: S11 Graph of the Proposed Antenna

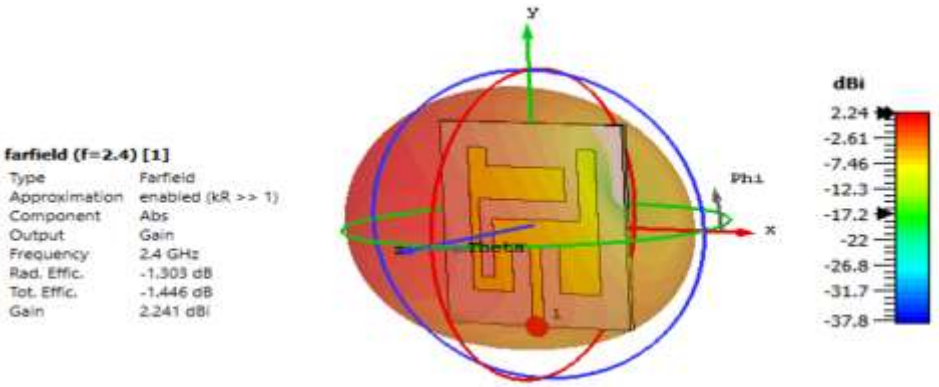

Figure 3: Simulated 3D Radiation Pattern at 2.4 GHz of the Proposed Antenna

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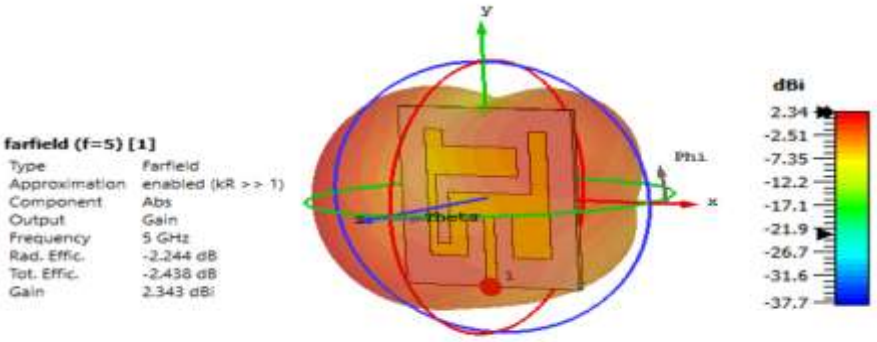

Figure 4: Simulated 3D Radiation Pattern at 5 GHz of the Proposed Antenna

VSWR values of the antenna resonance frequencies are 1.42, 1.68 and 1.13 at 2.39 GHz, 3.07 GHz and 4.92 GHz, respectively.

4. RESULT AND DISCUSSION

In this work triband rectangular patch microstrip antenna is designed. According to the simulation results, antenna can work at 2.4 GHz and 5 GHz frequency bands. In literature, there are several multiband antenna, some of them compared with the proposed antenna in Table 3. According to the Table 3, proposed antenna return loss parameters are appropriate for 2.4 GHz and 5 GHz frequency bands. Gain values can be given as 2.24 dBi and 2.34 dBi at 2.4 GHz and 5 GHz, respectively. Bandwidth of the antenna is given in Results section. As a result, antenna parameters are good enough compared to the antennas in the literature.

Table 3: Comparison of Antennas

Ref.	Frequency (GHz)	S_{11} (dB)	Gain (dBi)
[6]	2.45 3.7 5.8	-27 -28 -27	-1.24 -2.59 -0.45
[17]	2.4	-17.29	3.93
[19]	2.5 5.8	-29.9 -15.16	1.37 3.9
In this work	2.39 3.07 4.92	-15.08 -11.88 -24.03	2.25 3.76 1.92

5. CONCLUSION

In this work, a simple microstrip patch antenna is designed for Bluetooth and WiFi applications. The designed antenna is simulated using CST MWS software. According to the simulation results, IEEE 802.11ac/b/g standards are supported by the antenna. So the antenna can be used for Bluetooth and 2.4/5 GHz WiFi applications.

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