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Wi-Fi ANTENNA DESIGN FOR E-HEALTH KIT BASED BIOTELEMETRY MODULE

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ABSTRACT

In rapidly developing technology, most of engineering applications need to be done remotely. An antenna is needed to transmit the values received as a result of these remote studies. The antenna type that is more suitable to use in line with this need is the Wi-Fi antenna. Although this antenna is low in cost, it provides benefits to the user by using a good band. In this study, a Wi-Fi antenna design at 2.4 GHz frequency for use in the E-Health kit-based biotelemetry module is discussed. In this designed antenna, FR-4 substrate with dielectric coefficient of 4.3 is used. In the ground and patch parts, copper was used as the material. The return loss is 13.54 dB at 2.4GHz operating frequency with the gain value of 2.75 dBi. It was aimed to use this antenna as a Wi-Fi antenna in the E-Health kit-based biotelemetry module.

Keywords: E-Heath, Biotelemetry, Wi-Fi, Antenna, CST

1. INTRODUCTION

With the continuation of this way of life, the need for close medical assistance has increased for more people. In this regard, the need for systems that provide medical warnings about health has increased. The focus of this study is to design a low-cost Wi-Fi antenna for the reliable e-health monitoring devices. Biotelemetry is defined as the transfer of biomedical signals and parameters to a distant recorder using methods that do not create significant disruptions and constraints to the monitored animal or person (Nikolayev and Denys et al., 2019). This results the patient specific biological data to be measured by using the E-health kit equipment where these data can be transmitted to the doctor at hospital to determine if any medical treatment has to be conducted for the patient by the doctor. Microstrip antennas are now commonly employed in biotelemetry due to their low-profile comfort on planar and non-planar surfaces. In addition to the physical requirements to be fulfilled for the modular compactness of E-Health kit-based biotelemetry systems, the emerging requirements of the wireless systems are high directivity, large gain, efficient and broadband operability of the antennas. Many techniques have been investigated in order to meet the design requirements ranging from the inclusion of different shaped slots or radiating patches (Balanis, C. A. (2015); Ahson, S. A. and Ilyas, M. (Eds.). (2018)) up to the utilization of artificial metamaterials (D.Wand and C.H. Chan(2016);Chakraborty et al. (2014)) in the radiating element design (Palandoken et al.(2009);Palandoken et al. (2010)). Adit Kurniawan and Salik Mukhlishin propose a broadband antenna design approach to produce a single antenna that can be used by various wireless technologies using different frequencies from 2.3 to 6.0 GHz, covering 2.4-2.48 GHz, 5.15-5.35 GHz WiFi frequencies (Kurniawan and mukhlishin(2013)). Raad H. Thaher and Zainab S. Jamil designed a dual-band rectangular microstrip patch antenna with microstrip lines in their study in 2018(Thader and Jamil (2013)). The proposed antenna is designed on FR-4 substrate. The antenna is designed to operate in the 2.4/5.8 GHz bands for Wi-Fi/WiMax applications. The resulting return loss is -32.77 dB at 2.4 GHz at 7.4% bandwidth and -25.955 dB at 5.8 GHz with 8.17% bandwidth.

The paper is structured as follows. In Chapter 2, a discussion will be made about the design, dimensions, feeding methods of the designed antenna and the preferred application for simulation. In Chapter 3, the simulation results of the designed antenna are presented. In the fourth chapter, a comparison of the literature is made and the difference between the antenna and the past is presented. In the last chapter, chapter 5, the general summary of the study is explained (Zhou and Noordin et al. (2011); Kim et al. (2000); Chung and Chang (2020)). With the numerical studies carried out, the dimensions of the antenna were changed and the most ideal dimensions were tried to be obtained by drilling holes on the selected surface. In order to comply with WIFI standards, the recommended antenna operating frequency should be 2.4 GHz. Microstrip antenna was chosen in order to design an antenna with small dimensions and high gain (Shi and Ding (2015)).

This technology requires high performance antennas. It should also be cost-effective and easy to manufacture.

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2. MATERIAL AND METHODS

2.1 Design of antenna

It was aimed to reduce the size of the antenna and make the antenna cheaper in terms of cost. With this cheaper shape, we make a slot in the ground part of the antenna. In this way, it was adjusted the operating frequency of the antenna to operate in correct bands. In the patch part, it was drew the antenna as a Wi-Fi (Zhu and Eleftheriades (2009)). Then we fed it as microstrip. Port assignments were tried in order. According to these results, it was determined as a waveguide.

2.2 Material

The material used in the ground part is copper. The thickness of this material is 0.035 mm. The slot has been structured on the ground plane of the antenna, to set the operating frequency. A 38 mm x 11 mm slot was opened. FR-4 material with a dielectric coefficient of 4.3 was used as a substrate. Its thickness is 1.6 mm (Karmokar and Morshed et al. (2010)). The material used in the patch part is copper. The reason for using copper again is to provide integrity in the antenna. In this way, antenna will work more clearly. Its thickness is 0.035 mm. At the junction of the feed and the patch, slots were opened on the sides and made suitable for the desired frequency.

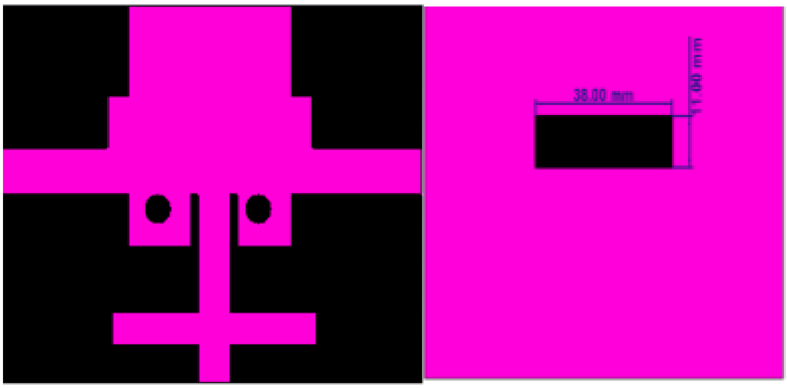

Figure 1: Front and Back View

Table 1. Parameters of Antenna

Top length	39 mm
Top height	19 mm
Under top length	49 mm
Under top height	11 mm
Circle radius	3 mm
Height	100 mm
Length	80 mm
Feed size	40x7 mm

2.3 Feeding Properties

There are four different methods generally used in antenna designs (Pei and Zeng (2019)). The prominent ones are microstrip feeding, coaxial feeding, aperture feeding and proximity feeding methods (Baytore et al. (2019)). All feeding types were tested one by one. The most uniform results were observed in microstrip feeding. For this reason, microstrip feeding was preferred as the feeding type. Accuracy -40 dB was chosen before simulation.

3. FINDINGS

It has been observed that the proposed antenna operates at a frequency of 2.4 GHz. The gain of this antenna is 2.75 dBi. The return loss value, operating frequency and bandwidth can be observed when investigating the S parameter. In the radiation pattern part, we observe the gain and pattern of the antenna. A slot was made on the ground of the antenna, the operating frequency was increased, and it was tried to convert to dual-band. However, in this way, the efficiency received from the antenna decreased. Also, changes have been made so that the antenna only works on the 2.4 frequency. Reducing the surface area has been achieved. Parametric changes were

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observed in the antenna by opening various slots or increasing and decreasing the indentations. From 2.39 GHz frequency to 2.43 GHz frequency. decreasing the indentations. From 2.39 GHz frequency to 2.43 GHz frequency.

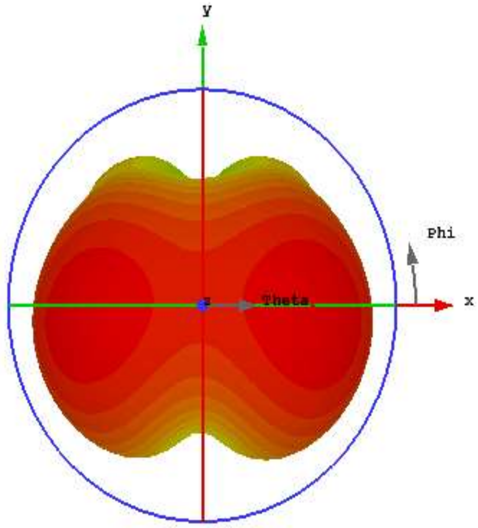

Figure 2: Radiation Pattern of the Antenna

Figure 1 shows the front and back views of the designed antenna. In Figure 2, the radiation pattern of the designed antenna is seen.

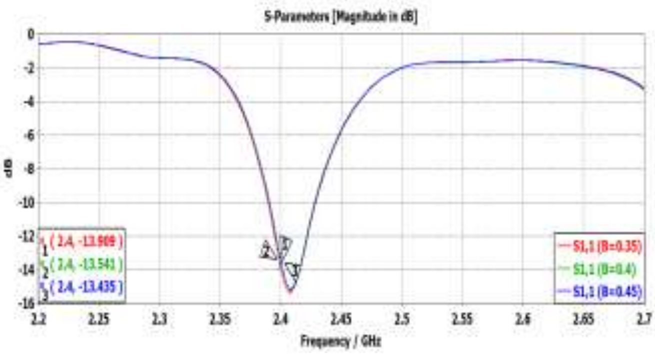

Figure 3: S Parameters of Parametric Sweep the Designed Antenna in dB

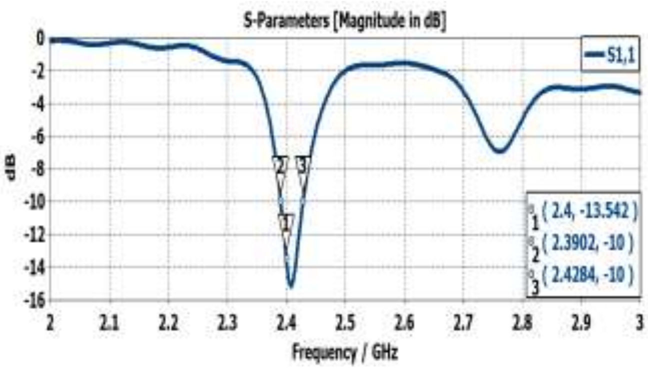

Figure 4: S Parameters for the Designed Antenna in dB

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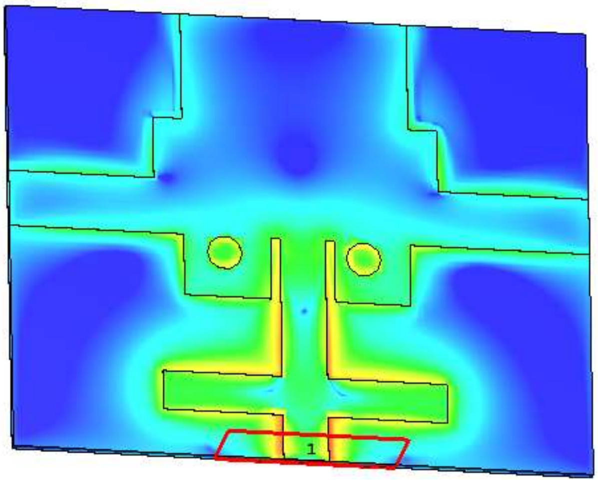

Figure 5: Current Density

In Figure 3, the s parameter graph of the parametric analysis is observed. Figure 3 shows the s parameter graph analyzed parametrically at three different values. These are the values 0.35, 0.4 and 0.45. In Figure 4, the s parameter and bandwidth of the antenna used are shown. From 2.39 GHz frequency to 2.43 GHz frequency is antennas bandwidth Current density of the proposed antenna in Figure 5 and it works at 2.4 GHz. The current density in the feeding part is higher than the other parts.

4. RESULT AND DISCUSSION

Compared to previous studies, the surface area was reduced in this study. In this way, a cost saving has been achieved and the product has been brought cheaper. The importance of this study is to design an external Wi-Fi antenna for the biotelemetry module to be used in health applications. Thanks to this external antenna, the received power level will be higher. Thanks to this product, which is more useful and cheaper than its counterparts in the market, easy use and less money expenditure are promised for users. In another article (Wang and Chang (2016)) the gain is very good, However, in our study, these features belonging to both were combined and both gain and surface area were made more suitable.

5. CONCLUSION

As a result, this antenna operating at 2.4 GHz is one step ahead of its counterparts in the market, both in terms of aesthetics and efficiency. It is more suitable than its peers due to its efficient operation in the range of 2.39-2.43 and its low cost. Also, it has 2.75 dBi gain. By the way return loss is 13.54 dB. Since this product is already expensive, an antenna that is more affordable in terms of price is designed with the reduction of the surface area rather than the gain in this type of antenna.

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REFERENCES

Ahson, S. A., & Ilyas, M. (Eds.). (2018). WiMAX: applications. CRC press.

Balanis, C. A. (2015). Antenna theory: analysis and design. John wiley & sons.

BAYTÖRE, C., GÖÇEN, C., PALANDÖKEN, M., Kaya, A., & ZORAL, E. Y. (2019). Compact metal-plate slotted WLAN-WIMAX antenna design with USB Wi-Fi adapter application. Turkish Journal of Electrical Engineering & Computer Sciences, 27(6), 4403-4417.

Chakraborty, U., Kundu, A., Chowdhury, S. K., & Bhattacharjee, A. K. (2014). Compact dual-band microstrip antenna for IEEE 802.11 a WLAN application. IEEE antennas and wireless propagation letters, 13, 407-410.

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Available online 20 March 2022;
doi: 10.46291/ICONTECHvol6iss1pp63-67

Chung, M. A., & Chang, W. H. (2020). Low-cost, low-profile and miniaturized single-plane antenna design for an Internet of Thing device applications operating in 5G, 4G, V2X, DSRC, WiFi 6 band, WLAN, and WiMAX communication systems. Microwave and Optical Technology Letters, 62(4), 1765-1773.

D. Wang and C. H. Chan, "Multiband Antenna for WiFi and WiGig Communications," in IEEE Antennas and Wireless Propagation Letters, vol. 15, pp. 309-312, 2016, doi: 10.1109/LAWP.2015.2443013.

Karmokar, D. K., Morshed, K. M., Numan-Al-Mobin, A. M., & Kabir, A. E. (2010). High gain multiband loaded inverted-F antennas for mobile WiMAX, Wi-Fi, bluetooth and WLAN operation. International Journal of Engineering (IJE), 4(3), 219-232.

Kim, M. K., Kim, K., Suh, Y. H., & Park, I. (2000, July). A T-shaped microstrip-line-fed wide slot antenna. In IEEE Antennas and Propagation Society International Symposium. Transmitting Waves of Progress to the Next Millennium. 2000 Digest. Held in conjunction with: USNC/URSI National Radio Science Meeting (C (Vol. 3, pp. 1500-1503). IEEE.

Kurniawan, A., & Mukhlishin, S. (2013). Wideband antenna design and fabrication for modern wireless communications systems. Procedia Technology, 11, 348-353.

Nikolayev, Denys, Maxim Zhadobov, and Ronan Sauleau. "Immune-todetuning wireless in-body platform for versatile biotelemetry applications." IEEE transactions on biomedical circuits and systems 13.2 (2019): 403-412

Palandoken, M., and H. Henke. "Fractal negative-epsilon metamaterial." 2010 International Workshop on Antenna Technology (iWAT). IEEE, 2010.

Palandoken, M., and H. Henke. "Fractal spiral resonator as magnetic metamaterial." 2009 Applied Electromagnetics Conference (AEMC). IEEE, 2009.

Pei, Z., Ji, L., Zeng, X., Zhang, L., & Liu, C. (2019, October). A Compact Frequency Reconfigurable Patch Antenna. In 2019 International Symposium on Antennas and Propagation (ISAP) (pp. 1-2). IEEE.

Shi, S. J., & Ding, W. P. (2015). Radiation pattern reconfigurable microstrip antenna for WiMAX application. Electronics letters, 51(9), 662-664.

Thaher, R. H., & Jamil, Z. S. (2018). Design of dual band microstrip antenna for Wi-Fi and WiMax applications. Telkomnika, 16(6), 2864-2870. Reis, P., & Virani, H. G. (2020, July). Design of a Compact Microstrip Patch Antenna of FR-4 Substrate for Wireless Applications. In 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC) (pp. 713-716). IEEE.

Zhou, W., Noordin, N. H., Haridas, N., El-Rayis, A. O., Erdogan, A. T., & Arslan, T. (2011, November). A WiFi/4G compact feeding network for an 8-element circular antenna array. In 2011 Loughborough Antennas & Propagation Conference (pp. 1-4). IEEE.

Zhu, J., & Eleftheriades, G. V. (2009). Dual-band metamaterial-inspired small monopole antenna for WiFi applications. Electronics letters, 45(22), 1104-1106.

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