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MICRO-STRIP PATCH 2.4 GHz Wi-Fi ANTENNA DESIGN FOR WLAN 4G- 5G APPLICATION

WLAN 4G-5G UYGULAMASI İÇİN MİKRO-ŞERİT YAMA 2.4 GHz Wi-Fi ANTEN TASARIMI

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ABSTRACT

In this study, an antenna with a frequency of 2.4 GHz has been designed that can be used in new generation wireless communication systems, which are in high demand with the development of technology. The designed antenna has Wi-Fi operating frequency range according to IEEE 802.11 standards. While choosing the antenna design, micro-strip antenna was preferred due to their geometry, lightness, low cost of production and compactness. While designing the antenna, the CST microwave studio program was deemed appropriate to be used and the necessary measurements were made. It has been deemed appropriate to use copper in the ground and patch parts of the antenna design. ROGERS 5880 (RT5880), for micro-strip circuit applications, was preferred as the substrate material. The dielectric coefficient of the selected material is 2.2. Its thickness is taken as 0.81 mm. As a result of the design, most of the intended goals were achieved. The gain of the designed antenna is measured as 2.73 dBi return loss value 30 dB and the bandwidth as in the 2.33-2.48 GHz range. These results are acceptable according to the standards. The 2.4 GHz antenna designed in this study can be used for Wi-Fi studies according to the experimental results.

Keywords: Wi-Fi, Antenna, CST, Micro-strip, Wideband

1. INTRODUCTION

Today, with the increase in the need for wireless communication, the equipment in this technology field has started to develop and change (Balanis, C. A. (2015)). Antenna designs and new technological solutions in wireless communication systems are realized in line with consumers' requests for fast, quality and reliable information (Palandoken et al. (2020)). Microwave and millimeter wave components (Montero and Javier et al. (2013); Rymanov and Vitaly et al. (2012); Palandoken et al. (2012); Palandoken et al. (2014); Palandoken et al. (2014)), which have been in use for a period of time, now starting to change with new wireless component designs that are compatible with technological breakthroughs. The most important example of these type of wireless components is WLAN (wireless local area network) components (Palandoken et al. (2019)). The increase in the use of wireless and mobile network communication systems has also increased the use of WLAN systems. This increase has caused the systems to be inadequate. With the technological developments, the increasing demand rate of WLANs today has led to the design of low-profile, lightweight, and single-feed different antenna structures for WLAN devices to fit into a small equipment area (Palandoken (2017)). For this reason, smaller designs have begun to be needed in WLAN devices. In order to eliminate this deficiency, development, improvement and performance enhancement studies have been started (Pozar,D.M.(2011)) Firstly, antennas to be used in this technology started to be developed. This technology requires high-performance antennas (Thaher and Jamil (2018)). It should also be cost-effective and easy to manufacture. Micro strip antenna, which is the most advantageous option that meets the demand in accordance with this definition, is discussed. The practicality of use, ease of production, lightness and adaptability to the applied surface of the micro strip antenna have made it widely used in recent years. Antennas have a certain frequency range to operate. IEEE 802.11 standards were taken into account while determining the frequency ranges (Ali,M.A.(2015)). IEEE 802.11 standards are the general name of the developed wireless networks. 802.11 standards represent protocols created over WLAN within the local network. Micro strip antennas also have some disadvantages. However, most of the studies are aimed at reducing these disadvantages (Kurniawan and Mukhlishin (2019)). The main problem of micro strip antennas is narrow bandwidth. The most important work done to solve this problem is to change the supply line. Another development work is to make changes to the antenna geometry. With the studies carried out, the dimensions of the antenna were changed and the most ideal dimensions were tried to be obtained by drilling slots on the selected surface (Hasan and Rahman et al. (2019)). They aimed to design the best micro strip antenna in terms of return loss and antenna gain. When making comments about an antenna, need to know the antenna parameters well. While deciding on the most suitable antenna geometry, need to change many parameters. Because R&D-based studies in wireless communication systems are mostly small-scale and more effective performance studies (Nayak and Endluri et al. (2021)). Many trial and error methods were followed during these studies.

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The paper is structured as follows. In Section 2, a discussion will be made about the design, dimensions, feeding methods of the designed antenna and the preferred application for simulation. In Section 3, the simulation results of the designed antenna are presented. In the 4 section, a comparison of the literature is made and the difference between the antenna and the past is presented. In the last section, section 5 the general summary of the study is explained.

2. MATERIAL AND METHOD

The general design of the designed Wi-Fi antenna is given in Figure 1. Antenna parameter dimensions are given in Table 1.

2.1 Antenna Design

There are 3 important parts of the antenna while designing a micro-strip antenna (Genc and Basyigit et al. (2018)). Ground - Patch – Substrate. While designing the antenna, the first step is to make the ground layer, which is the conductive layer. The ground material of the antenna designed is copper and its thickness is 0.035mm. This layer must be conductive. It was deemed appropriate to choose copper in order to be cost-effective. The second layer is the substrate layer. The material ROGERS 5880 was chosen for this layer. Its dielectric coefficient is 2.2. Generally, FR4 material is used in antenna designs, but it was not used in this design because as a result of necessary trials, this material did not give the desired results (Saadh and Ashwath et al. (2020)). The other layer is the patch part. The patch layer is the layer on which the antenna radiates. This part should be conductive. Choosing copper was deemed appropriate. Its thickness is taken as 0.035 mm. It is aimed to bring the antenna to the desired frequency by making changes on this layer. After the necessary parametric analyzes were made, it took the shape shown in Figure 1.

2.2 Antenna Feed

There are many feeding methods for the designed antennas (Kutuk and Tasneli et al. (2000)). Micro-strip feed line is used for the antenna designed in this article. Optimal results were obtained with this feeding. The input impedance between the feed line and the antenna should be normalized. The normalized result is the input impedance of 50 ohms, because this value is the internationally accepted value. It is an important value for the proper integration of the antenna and the feed line (Turker and Gunes et al. (2007)).

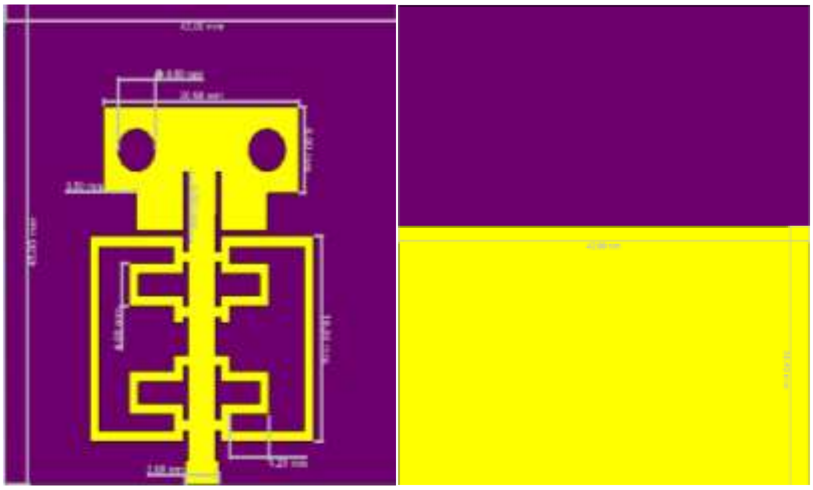

Figure 1: Proposed antenna design

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Table 1. Design parameters of proposed antenna

Parameter	Measurement
Ground L	26.4 mm
Ground W	42 mm
Substrate L	45 mm
Substrate W	42 mm
Feed W	3.6 mm
Feed L	30 mm

2.3 Simulation and Measurement

The CST microwave studio program was used to design the antenna. The S (1, 1) gain return loss radiation pattern graphics of the designed antenna were examined and the results were interpreted.

3. FINDINGS

In this study, a Wi-Fi antenna operating at 2.4 GHz was obtained by using a microstrip patch antenna. Microstrip feeding was used as feeding and waveguide port assignment was made. The return loss value of the designed antenna was measured as 30 dB. The antenna operates between the frequency values of 2.48 GHz - 2.33 GHz. This antenna gain has a value of 2.83 dBi. Optimum values were obtained by performing various parametric studies. The studies and the results obtained were shown and evaluated. As a result of this study, an antenna with the desired values was obtained.

The results of the simulations of the antenna designed in the CST microwave studio program were examined. The necessary results and graphics for the antenna are given below.

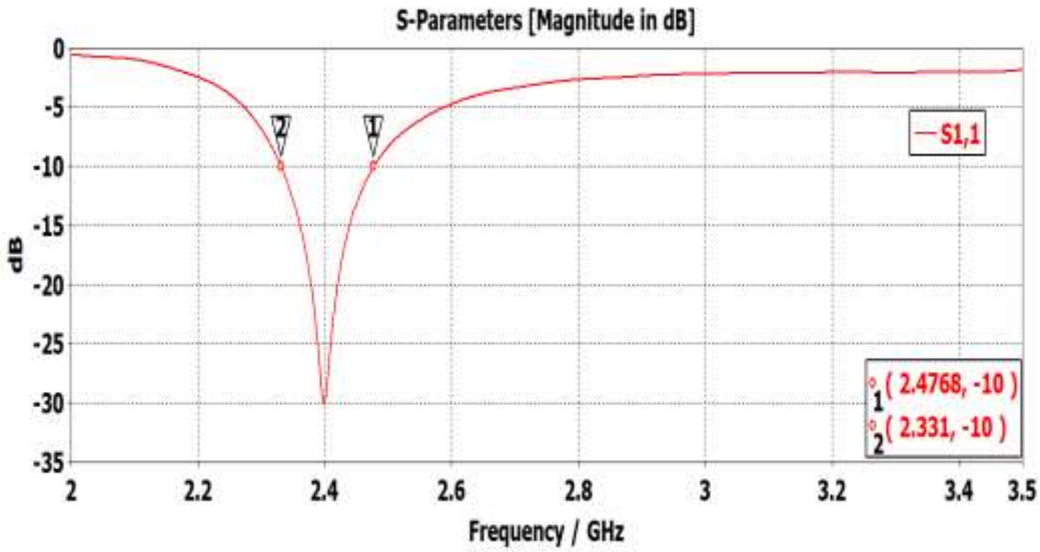

Fig. 2 Return loss of proposed antenna

The S parameter graph of the designed antenna is shown in Figure 2. According to the graph it was examined, the Wi-Fi antenna operating frequency has a return loss value of 30 dB. 30dB return loss value is a very good result for the antenna (Chung and Chang (2020)). ($S11 \leq -10$ dB). The operating frequency range of the designed antenna is 2.48 GHz - 2.33 GHz.

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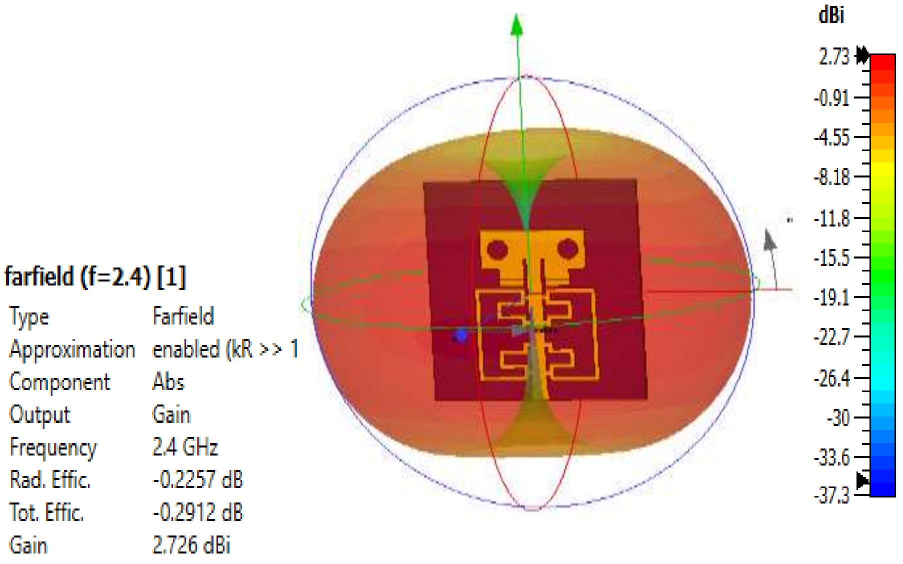

Fig. 3 Radiation Pattern of proposed antenna

The gain of the designed antenna was obtained as 2.73 dBi as seen in Figure 3 (Shi and Ding (2015)).

4. RESULTS AND DISCUSSION

In this study, a Wi-Fi antenna operating at 2.4 GHz was obtained by using a microstrip patch antenna. Microstrip feeding was used as feeding and waveguide port assignment was made. The return loss value of the designed antenna was measured as 30 dB. The antenna operates between the frequency values of 2.48 GHz - 2.33 GHz. This antenna gain has a value of 2.83 dBi. Optimum values were obtained by performing various parametric studies. The studies and the results obtained were shown and evaluated. As a result of this study, an antenna with the desired values was obtained.

5. CONCLUSION

In these times when everything is connected and digitalized, the importance of wireless communication in the world is increasing day by day. Many studies have been carried out to remove the barriers to strengthening wireless communication. Wi-Fi antenna designs in the literature are the best examples of this. In these times and in the future, when the use of the Internet is indispensable, there is a great need for Wi-Fi antennas. This antenna it was designed has a Wi-Fi operating frequency. Unlike other examples in the literature, its surface area is reduced and it has a unique structure. Low cost materials are used. Trials and simulations have proven this. Since the return loss value is very good, it can be used in necessary antenna designs.

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