Compact Dual-Band Broadband Microstrip Antenna for WLAN Applications

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***Abstract*— This paper presents a compact planar monopole antenna with dual-band operation suitable for wireless local area network (WLAN) application. The antenna occupies an overall area of 18 × 12 mm^2. The antenna combines two folded strips is fed by a coplanar waveguide (CPW) transmission line, which radiates at 2.4 and 5.2 GHz. Prototypes of the obtained optimized design have been simulated using HFSS. The simulated results show good dual-band operation with -10 dB impedance bandwidths of 50 MHz and 2400 MHz at bands of 2.4 and 5.2 GHz, respectively, which covers the 2.4/5.2/5.8 GHz WLAN operating bands.**

Keywords—Dual-band; wireless local area network (WLAN); CPW feed antenna; Dual-frequency

I. INTRODUCTION

With the rapid development of wireless applications, there is a high demand to increase the data rate of wireless communication systems [1]. The growing demand for WLAN technology has led to an interest in integrating the 2.4 GHz (IEEE 802.11b/g) and 5.2 GHz (IEEE 802.11a) frequency bands into a single device that requires a dual-band antenna. WLAN antenna not only has a wider frequency band, smaller size, and is easier to install, but also has a high radiation efficiency [2]. Due to space limitation, WLAN system should have multi-band and small antenna size [3]. In the design of multi-band antenna, one critical technique is to reduce the radiation caused by the currents distributed on the ground plane to improve the radiation patterns and impedance bandwidth [4]. A lot of research has been done on multi-band antenna, where co-planar waveguide (CPW) fed antennas show better behaviour for the wireless applications.

TABLE I. COMPARISON OF PROPOSED ANTENNA PERFORMANCE

Published Literature	Antenna Size (mm^2)	Total Area (mm)	Frequency Bands
Ref [4]	25x25	625	2.4/5.2/5.8GHz
Ref [5]	46x20	920	2.4/5GHz
Ref [6]	24x25	600	2.4/5.6GHz
Ref [7]	26x15	390	2.4/5.2/5.8GHz
Ref [8]	29x16	464	2.4/5.2/5.8GHz
This Work	**18x12**	**216**	**2.4/5.2/5.8GHz**

To cover all the three bands of WLAN, i.e. lower band of 2.4 GHz (802.11b/g standard) and upper bands of 5.15-5.35 GHz and 5.725-5.825GHz (802.11a standard), dual-band MIMO slot antenna for WLAN application are designed in [5, 6]. However, there is a limit in most of these antennas to achieving wideband characteristic especially at 5 GHz band for WLAN applications operating simultaneously at 5.2 and 5.8 GHz and large antenna size. Similarly, several dual-band slot antennas were proposed for wholly cover 2.4/5.2 GHz WLAN bands[7, 8]. Though the reported antennas cover all 2.4/5 GHz WLAN bands, they are not very compact in size. Thus, there is a demand for designing compact multi-band antennas. TABLE I. shows the comparison of antenna size and operating bands.

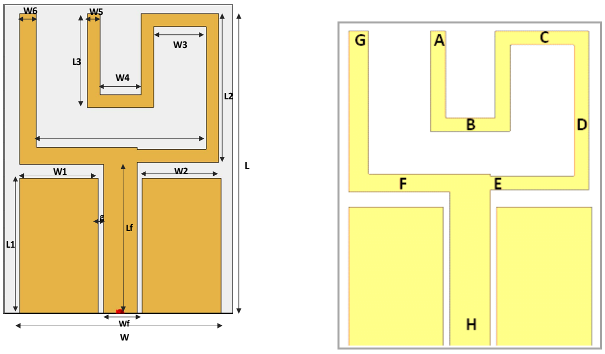
II. ANTENNA DESIGN

The geometry of the proposed antenna is shown in Fig. 1. The radiator and ground plane of the antenna are etched on a piece of printed circuit board with an overall size of 18 × 12 × 1.6 mm^3. The antenna has two monopole arms resonating at 2.4 GHz and 5.2 GHz. The antenna model consists of a coplanar ground plan, a radiation structure, and a feed line. A 50 Ω CPW transmission line, which consists of a signal strip width of 2 mm and a gap distance of 0.3 mm between the single strip and the coplanar ground plane, is used for feeding the antenna. The antenna is printed on the FR4 antenna substrate with a relative dielectric constant of 4.4. The ground plane of the antenna is printed on the same side of radiating element, whose length and width are represented by L_1, W_1, and W_2, respectively. The antenna is fed by a CPW line with a characteristic impedance of 50 Ω, and the size of the microstrip line is W_f × L_f. The detailed dimensions of the printed monopole antenna is given in TABLE I.

TABLE II. PROPOSED ANTENNA PARAMETERS

Parameter	L	W	W_f	L_f	g	L_1	L_2
Unit (mm)	12	17.5	2	8.7	0.3	7.9	8.67
Parameter	L_3	W_1	W_2	W_3	W_4	W_5	W_6
Unit (mm)	5.49	4.7	4.7	3.13	2.45	0.75	1

The electrical length of the whole monopole strip is equivalent to the quarter wavelength of the lower frequency band of 2.4 GHz (from point A to the open end at point G), while the L-shape branch (from point E to point G), which is a part of the folded loop, is mainly to generate the higher frequency band of 5.2 GHz, and the corresponding resonant quarter wavelength is obtained by adjusting the feeding network location. Further, the antenna element has been purposely folded not only to reduce the antenna physical dimension but also to reduce the coupling effect between antenna elements.



(a) (b)

Fig. 1. (a) Geometry of the Proposed antenna (b) Antenna's resonating arms

III. SIMULATION RESULTS

The simulated return loss of optimized antenna is shown in Fig. 2, it shows clearly that two operating bands are generated in 2.4 GHz and 5.2 GHz. The antenna elements resonated between 2.37 – 2.42 GHz and 4.9 –7 GHz with a minimum $|S_{11}|$ < -10 dB. The optimized antenna gives a bandwidth of about 40 MHz over a lower band of 2.4GHz and about 2.7 GHz over an upper band of 5.2/5.8GHz which is well compatible with the 802.11n WLAN standard.

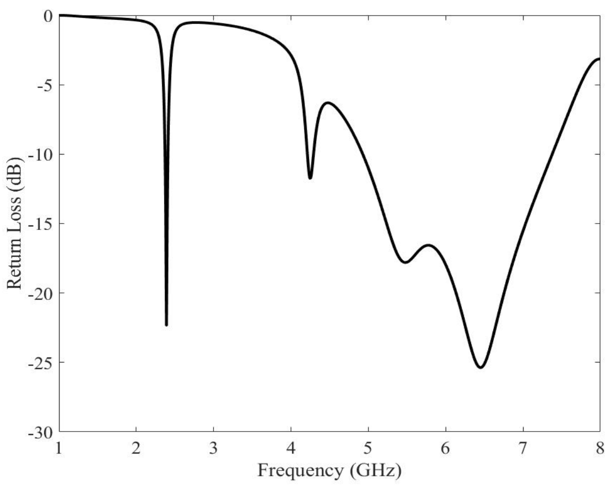


Fig. 2. Simulated return loss plot for proposed antenna design

Simulation result of antenna radiation pattern is shown in Fig. 3. The radiation pattern is nearly omnidirectional for both bands. It demonstrates that the antenna gain variation within 2.4 GHz and 5.2 GHz is minimal.

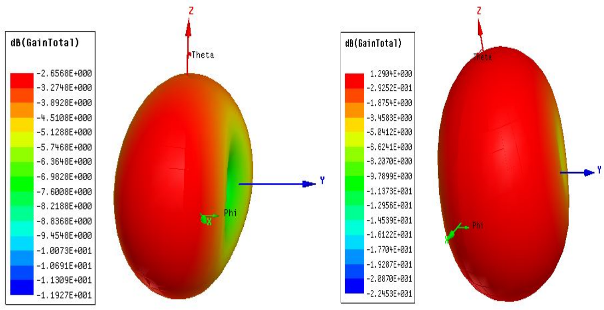


Fig. 3. Simulated 3D radiation patter for 2.4 GHz and 5.2 GHz

IV. CONCLUSION

A dual band compact planar monopole antenna for WLAN application is presented. The overall size of the antenna is 216 mm^3. Antenna is fed with CPW transmission line. The simulated results show that reflection coefficient, antenna resonance band and antenna gain of the proposed antenna satisfy the requirements of WLAN standard. In the proposed design, all the bands are covered with −10 dB reflection coefficient or less than that. The simulated results explore good dual-band operation with -10 dB impedance bandwidths of 40 MHz and 2700 MHz at bands of 2.4 and 5.2 GHz, respectively, which cover the 2.4/5.2/5.8 GHz WLAN operating bands.

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