A New Triple Band Antenna Design for GPS/ WLAN/ WIMAX Applications

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ABSTRACT

Abstract- In this work, a novel CPW antenna for wireless communication is proposed. Three practical frequency bands are achieved by three rectangular slots on the patch and a pair of L-shaped slots and rectangular slots on the ground. The proposed antenna size is 30×25×0.8 mm^3. Simulated results show that the presented antenna can cover three separated impedance bandwidths of 600 MHz (1.2–1.8 GHz), 400 MHz (2.2–2.6 GHz), and 2000 MHz (4.5–6.5 GHz), which are well applied for WLAN, WIVAX and GPS applications.

Keywords: multiband antenna; CPW; GPS; WLAN; WIMAX

Introduction

Depending on the rapid progress in communications systems, there is an increasing demand of internal multiband antennas. Many of wireless communication applications like Wireless Local Area Network (WLAN) and Worldwide Interoperability for Microwave Access (WiMAX) technology are required to operate together for use in GPS and Wi-Fi and another protocols. Recently, several works have appeared regarding the development of multiband and low-profile antennas for many applications in addition to GPS, WLAN and WIMAX applications [16-21]. Literature review of multiband antenna design could be summarized as: coplanar waveguide-fed L-loaded printed Inverted-F antennas [1], shorting pins of the loop antenna [3], L- and U-shaped slots [4], such as using three simple circular-arc-shaped strips [5], Inverted-F strips, S-shaped and a meandered strip [8], defected ground structure (DGS) and dual inverted L-shaped strips [9] and complementary split-ring resonator [10]. Besides, global positioning system (GPS) band is a critical operating frequency band that should be supported by internal multiband antennas of mobile devices. However, the polarization of the GPS antennas are so important parameters too [2,6]. However, for a GPS (1570–1580 MHz) receiver linearly polarized antennas can be also used [7,11]. In addition, covering both WiMAX and WLAN frequency bands in present of GPS frequency band is the biggest challenge for researchers [2–11]. In this work, a novel compact size multiband antenna for covering the GPS band (1.5 GHz), WLAN band (2.4 GHz) WiMAX band (5.5 GHz), has been proposed. Designing steps for getting all required bands will be proposed one by one.

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1. Antenna Design

In this section four steps have been followed for obtaining the multiband antenna. Simulation results for each step were analyzed. For designs and finding the improved parameters, Ansoft high frequency structure simulator software (HFSS, ver.16) was used. The proposed antenna is designed on a low cost and low profile FR4 substrate material with 0.8 mm thickness. Figure 1 shows the antenna designing steps. Ant. 1 includes only a feed line connected to rectangular plane and ground plane where just two resonances in 1.2 - 2.45 and 4.7 – 7 is achieved;

Ant. 2 includes rectangular slots, after creating the slots on the patch we could obtain three resonances (1.15-175, 2.2-2.4 and 3.5-5.85) improved. In Ant. 3 by cutting top of the ground and creating two L shape slots, we tried to more resonance and fine response but we achieved these frequencies 1.2-1.78 2.2 2.4 4.2-5.78. In Ant. 4 and final design creating two rectangular slots on the down of the patch, we achieved good results and obtained three resonances in 1.5, 2.4 and 5.5 GHz, as shown in figure 2.

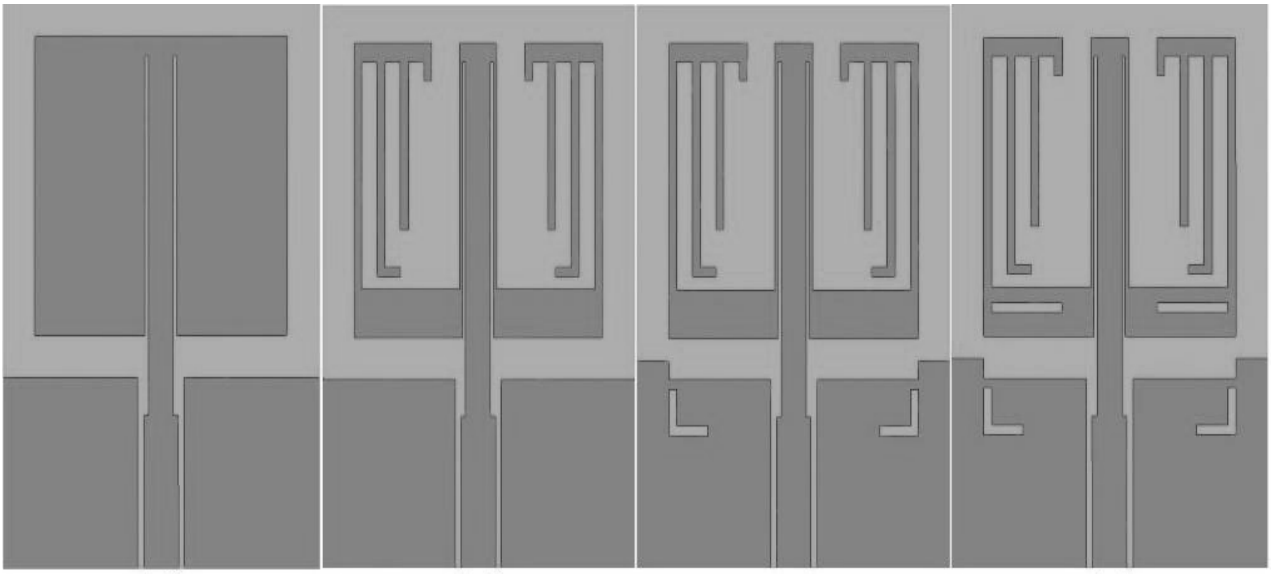


Figure 1: Four improved prototypes of the proposed antenna

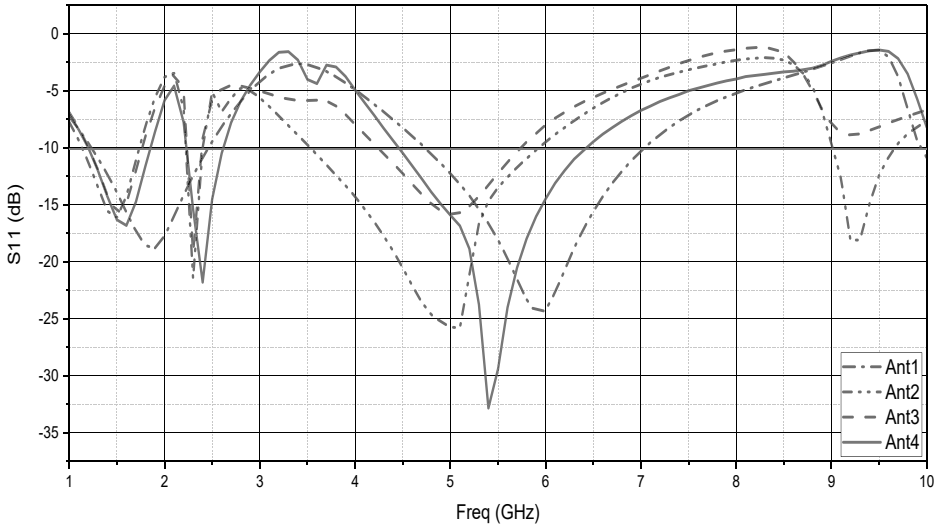


Figure 2: Simulated S11 for antennas (1-4)

1.1 RESULTS AND DISCUSSION

Figure 3 shows the geometry of the proposed multiband antenna. For simplification in the antenna design SH1 30.0 mm, SW1 20 mm, h = 0.8 mm were already selected. The rectangular radiating patch has been cut by rectangular slots and a pair of L-shaped slots in the ground. The impedance matching is improved by the tapered 50 Ω CPW feeding line. Dimensions of rectangular slots and L-shaped slots, has been adjusted for creating the three different resonant frequencies. The final dimensions of the proposed antenna are as follows (all dimensions are in millimeters): SW1 20, SW2 0.2, SW3 2.0, SW4 0.7, SW5 0.4, SW6 1.0, SW7 1.0, SW8 0.5, SW9 2.5, SW10 4.5, SH1 30.0, SH2 2.0, SH3 0.5, PH1 1.0, PH2 15.8, PH3 8.0, PH4 1.0, PH5 2.0, PH6 9.0, PH7 11.0, PH8 1.3,PH9 12.2, PW1 1.6, PW2 7.0, PW3 2.2, PW4 0.5, PW5 0.5, GH1 10.0, GH2 0.5, GH3 1.0, GH4 3.0,GH5 10.0, GW1 8.5, GW2 2.0.

According to the figure 4 (Reflection Coefficient (S_{11}) and Voltage standing Wave Ratio (VSWR)) three different bands are achieved successfully. 3-D and 2-D radiation patterns of the three resonances (1.5 GHz, 2.4GHz and 5.5 GHz) are shown in figure 5 and figure 6 respectively.

Proposed antenna compared with the characteristics of some antennas is shown in table 1.

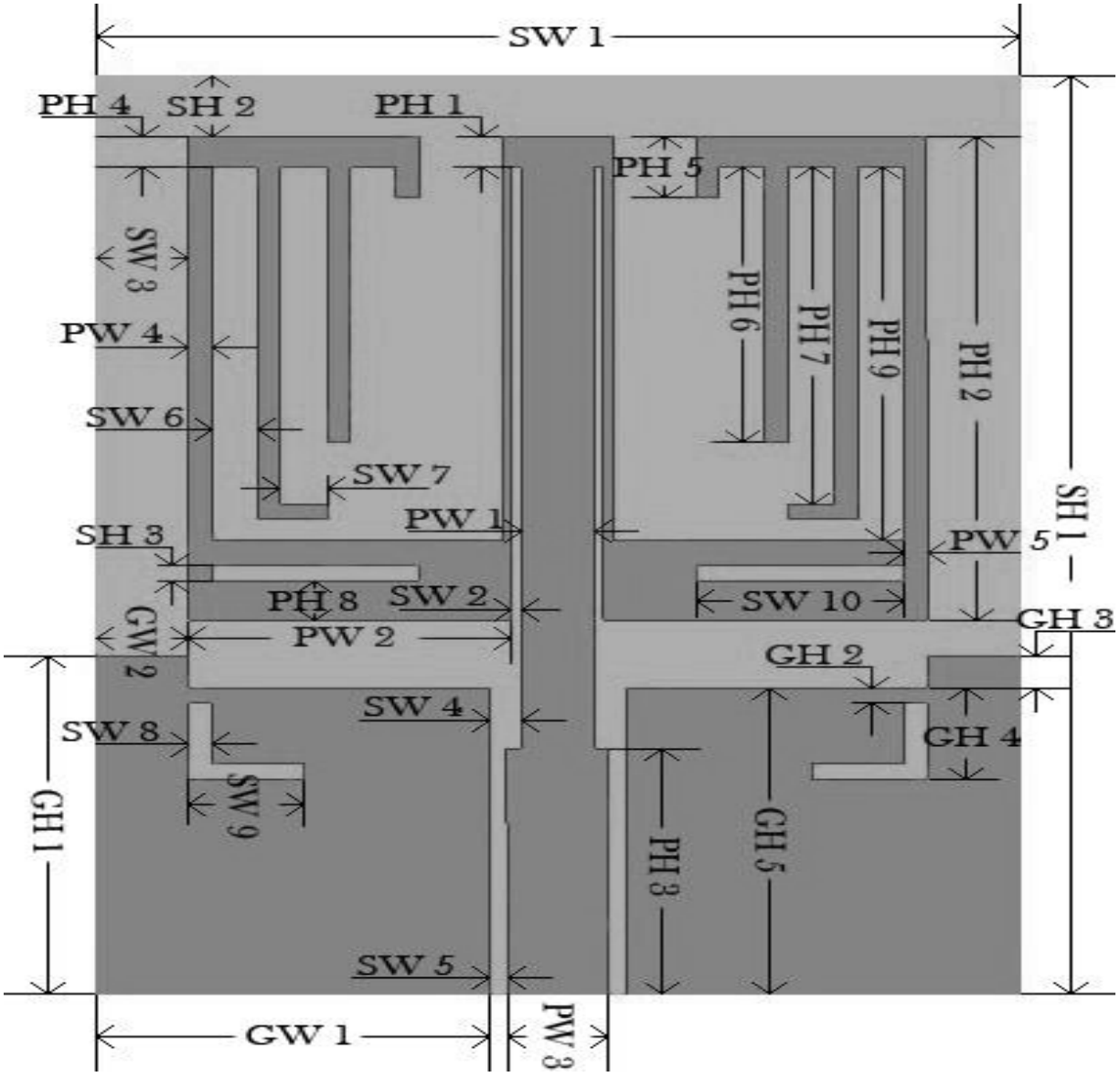
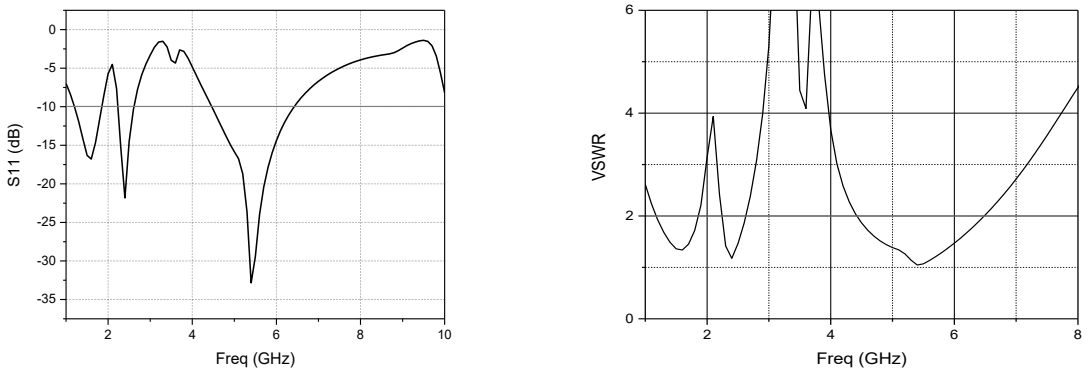


Figure 3: Geometry of the proposed antenna.

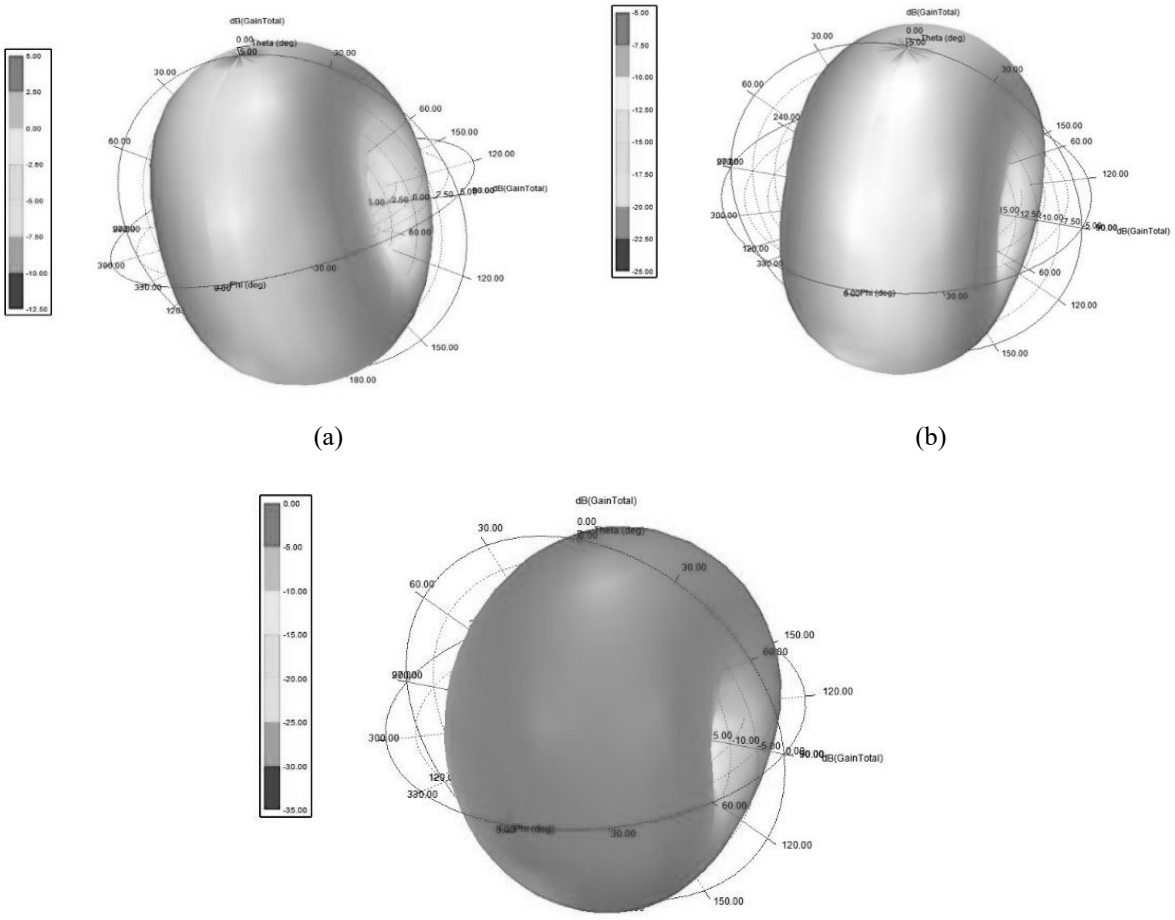
Table 1. Comparison of the simulated characteristics of some antennas with the proposed work

REF	SIZE (mm^3)	GPS	WLAN	WIMAX
12	30×25×1.6	-	2.4	-
13	23 ×36.5×0.8	-	2.4	3.5
14	50×30×1.6	-	2.4	-
15	25×30×1.6	-	-	5.5
Proposed antenna	30×20×0.8	1.5	2.4	5.5



(a) (b)

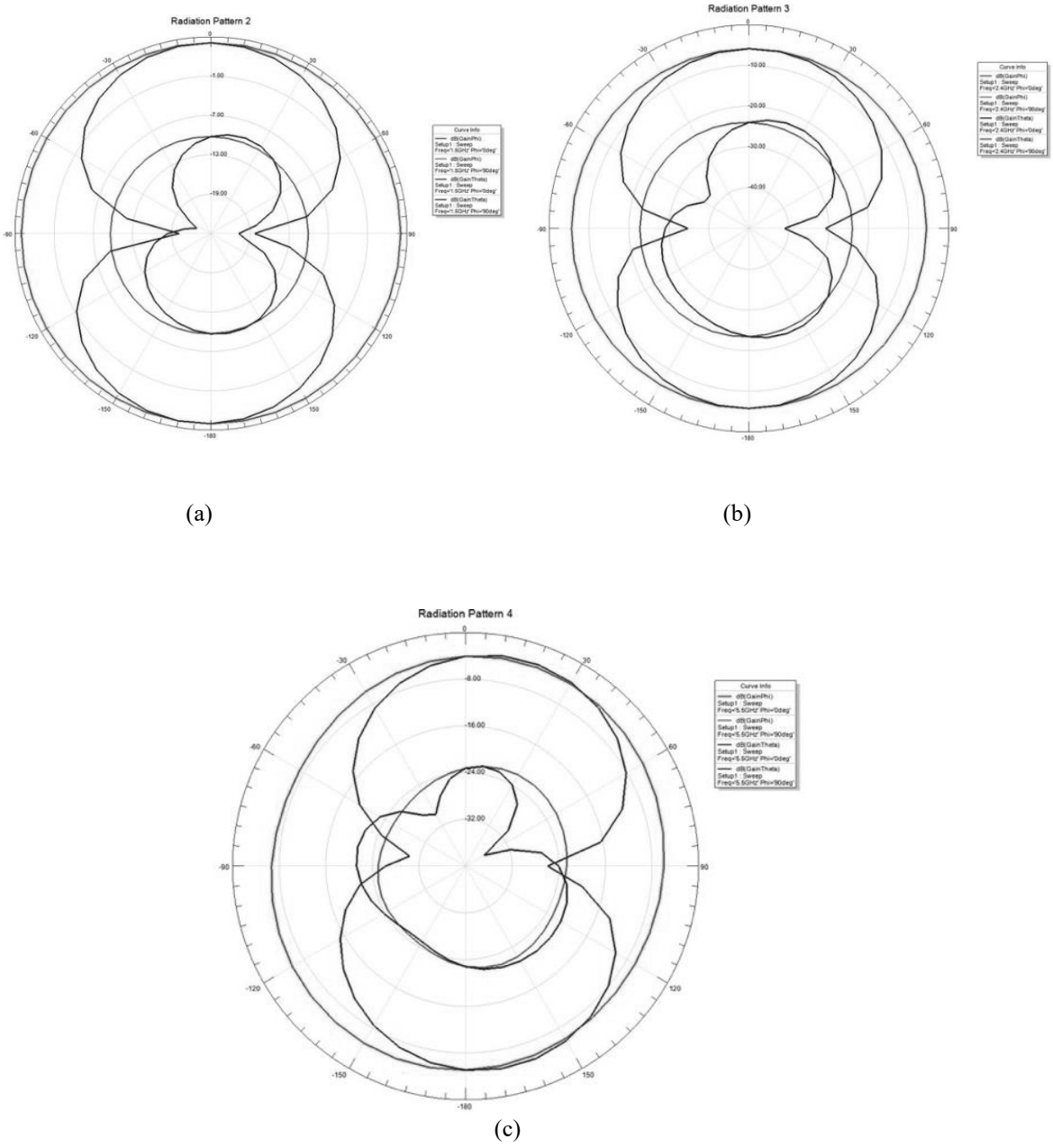
Figure 4: Simulated (a) S11 and (b) VSWR for the proposed antenna



(a) (b)

(c)

Figure 5: 3D radiation pattern in proposed antenna (a) 1.5 GHz, (b) 2.4 GHZ and (c) 5.5 GHz



(a) (b)

(c)

Figure 6: Simulated radiation patterns at 0 and 90 degrees (a) 1.5 GHz, (b) 2.4 GHz and (c) 5.5GHz

2. Conclusion

In this paper, a new multiband antenna is proposed for GPS, WLAN, and WiMAX applications. In the presented antenna, rectangular slots on the patch and L-shaped slot on the ground are used for getting multiband frequency ranges. Radiation performance of the antenna is acceptable too. In addition to the multiband frequencies, the compact planar size structure, low cost and easy fabrication are other advantages of the proposed antenna.

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