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U-Slot Microstrip Patch Antenna with Gain Enhancement

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Abstract—
Microstrip patch antennas are strong candidates for use in many wireless communications applications. In this paper, the design, optimization and simulation of a dual-band modified U-slot microstrip patch antenna for WiMAX/WLAN application is presented. It operates on 2.45-2.57 GHz and 5.1-5.4 GHz bands. Radiating patch lies on the Rogers RT/duroid 5880 substrate which is having low dielectric constant of 2.2. Coaxial feeding technique is used to feed the antenna with 50 ohm impedance. This proposed antenna enhances the return loss of -19.5 dB at the 2.5 GHz and -30 dB at 5.27 GHz frequencies. Computer simulated results showing the VSWR value lesser than 2 at the 2.45-2.57 GHz and 5.1-5.4 GHz frequency range of WLAN standards. It exhibits maximum gain of 6.15 dB at 2.5 GHz and 9.1 dB at 5.27 GHz.

I. INTODUCTION

The popularity of wireless communication systems has increased remarkably during the last decade and the market demand still continues to increase. Antenna plays a very important part in any wireless communication systems. Complexity is reduced and the performance of the receiver is enhanced by the well-designed antenna. Based on the application and the operating frequency of the antenna, the dimension, type and the configuration of the antenna will be chosen.Patch antennas play a very significant role in today's world of wireless communication systems. A microstrip patch antenna is very simple in the construction using a conventional microstrip fabrication technique. The most commonly used microstrip patch antennas are rectangular and circular patch antennas. These patch antennas are used as simple and for the widest and most demanding applications. The first patch antenna with U-slot was reported in 1995 fed by a probe with air as dielectric medium between patch and ground plane. The antenna showed wideband characteristics and provided an impedance bandwidth of 47%which was quite good because simple patch antenna hardly provides bandwidth of up to 2%. Microstrip antennas have several advantages like: low cost, easy fabrication and light weight. But they suffer from disadvantages like low gain and narrow impedance bandwidth. In wireless communications systems, a broadband system has been playing a very important role for wireless service requirements. Worldwide Interoperability for Microwave Access (WiMAX)/ Wireless local area network (WLAN) provides portable mobile broadband connectivity and thus provides a wireless alternative to cable and Digital subscriber line broadband access. In modern wireless communication systems, multiband antenna has been playing a very important role for wireless service requirements [1-4]. Now-a-days WLAN and WiMAX have been widely applied in mobile devices such as hand held computers and intelligent phones.

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These two techniques have been widely recognized as a viable, cost-effective, and high-speed data connectivity solution, enabling user mobility with the rapid development of the modern wireless communication system, antenna design has turned to focus on wide multiband and small simple structures that can be easy to fabricate. To adapt to the complicated and diverse WLAN and WiMAX environments suitable for WiMAX applications have rapidly increased. In this paper, a dual band modified U-slot microstrip patch antenna is designed, optimized and simulated. The antenna covers two frequency bands of 2.45-2.57GHz and 5.1- 5.4GHz. The proposed antenna can find applications in several communication standards used in WiMAX/WLAN.

II. ANTENNA DESIGN

Substrate selection is the first practical step in designing a patch antenna. Rogers RT/duroid 5880 (dielectric constant = 2.2 and h = 3.175mm) is used as substrate to design the proposed modified U-slot microstrip patch antenna. To feed the proposed antenna a coaxial probe of characteristic impedance 50 ohm is used. For ideal performance, it must converge to the center of voltage standing wave ratio (VSWR) point on Smith chart, where (VSWR=l). Typically, VSWR less than or equal to 2 or 10dB antenna bandwidth is considered for practical applications. Increase in substrate height h is considered as a common and effective method to achieve broadband antenna performance. It is not always practical to increase the substrate height beyond a certain range. The dimensions of the proposed U-slot microstrip patch antenna are shown below in TABLE I.

TABLE I

Dimensions of the proposed microstrip patch antenna

Parameter	*L*	*W*	*Ls*	*Ws*	*a*	*b*	*yf*
Units (mm)	36	29	30.75	12	2	3	11.7

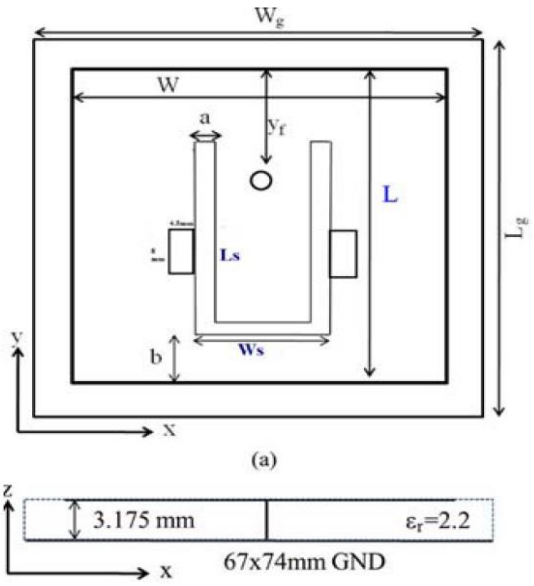

Fig.1.Geometry of the proposed modified U-slot microstrip antenna: (a) top view; (b) side view

III. SIMULATION RESULTS

In this section, the simulation and analysis is done for the proposed modified U-slot microstrip patch antenna by Ansoft HFSS. From these simulation results, the parametric studies are carried out. In this paper, the return loss, VSWR, radiation pattern and gain are simulated and analysed. The proposed antenna have impedance matching better than -10dB returnloss for frequency range of 2.45-2.57GHz and 5.1-5.4GHz. The operating frequencies of the proposed antenna design falls in IEEE802.11a (5.20GHz and 5.775GHz) and IEEE802.11b (2.45GHz) standards which allow WLAN operation. Fig.2 shows the current distribution in the patch of the proposed antenna. Fig.3 shows that the antenna have the return loss of - 19.1 dB at the 2.5GHz and -30 dB at 5.27GHz. Fig.4 shows the VSWR value lesser than 2 for the frequency range of 2.45- 2.57GHz and 5.1-5.4GHz. Fig.5 shows the radiation pattern of the proposed antenna.Fig.6 shows the 3D radiation pattern of the proposed antenna having maximum gain of 6.15 dB at 2.5GHz and 9.1 dB at 5.27 GHz frequencies respectively.

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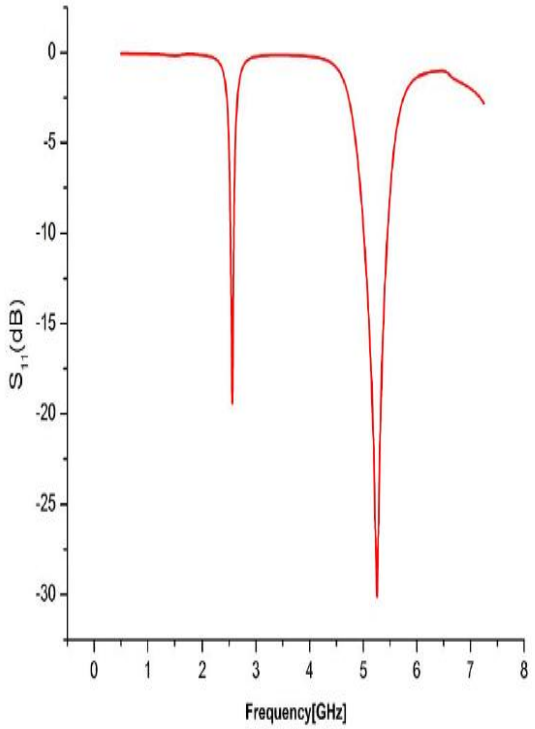


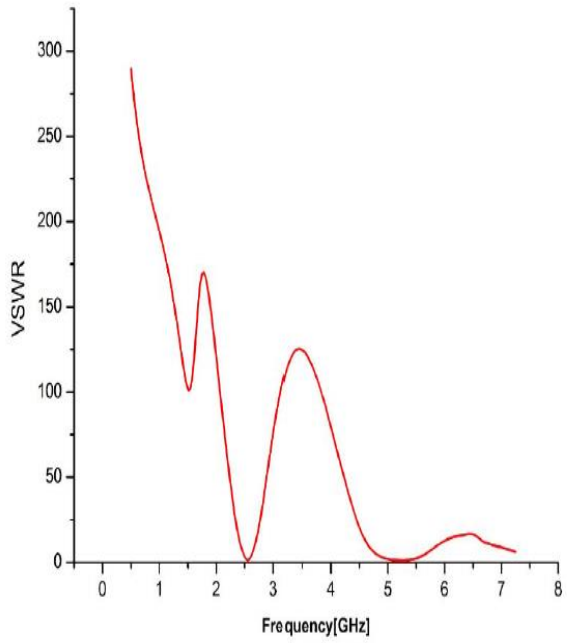
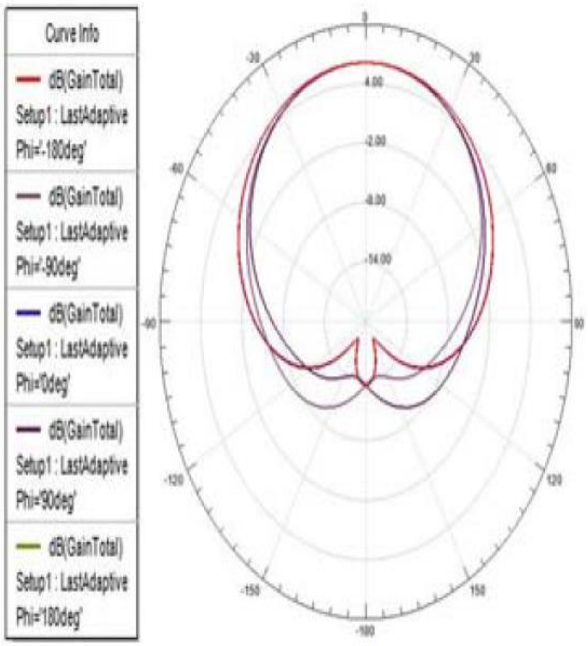


Fig.2 Simulated Return-Loss of the proposed antenna Fig.3 Simulated VSWR of the proposed antenna



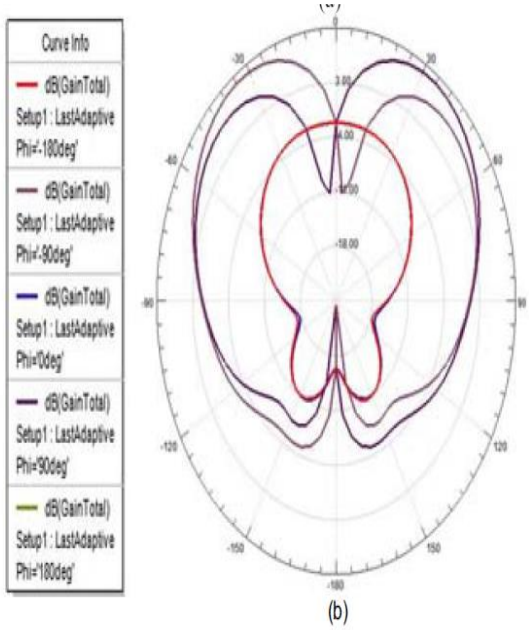


Fig.4 Simulated Radiation pattern of the proposed antenna at (a)2.5GHz and (b) 5.27GHz

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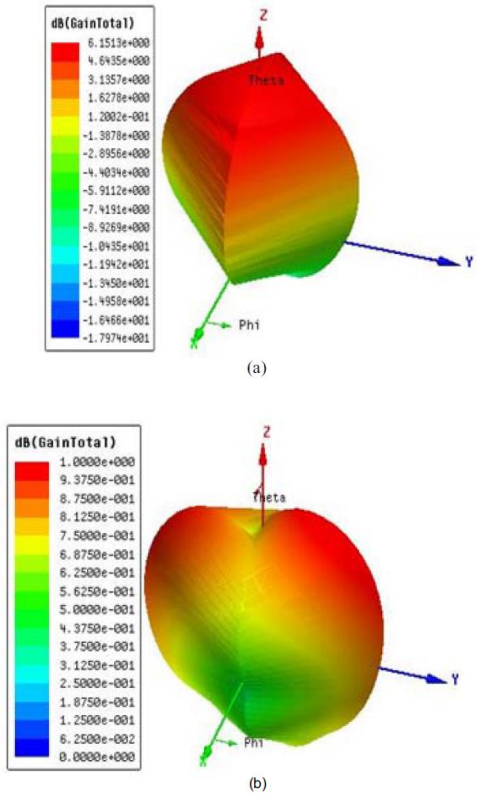

Fig.5 Simulated 3D Radiation pattern of the proposed antenna at (a)2.5GHz and (b) 5.27GHz

IV. CONCLUSION

The characteristics of proposed modified U-slot microstrip patch antenna have been analysed through different parametric studies using Ansoft HFSS simulation software. The proposed antennas have achieved good impedance matching, stable radiation patterns and satisfied return loss. The proposed antenna have the return loss of -19.1 dB at the 2.5GHz and -30 dB at 5.27 GHz and VSWR value lesser than two at the 2.45-2.57GHz and 5.1-5.4GHz frequency range. Thus, this antenna design can be used for WiMAX/WLAN application in the frequency range of 2.45 to 2.57GHz and 5.1 to 5.4 GHz.

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