Design and Analysis of a compact Band-Rejected UWB Antenna

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Abstract— **in this paper a new structure of ultra wideband antenna with one notched band is proposed and analyzed in detail. Creating a hemicycle shaped slot can achieve 5 to 6 GHz band-rejected performance. The antenna operate well for UWB applications, most cover a frequency range between 3.1 GHz to 10.6 GHz. Indeed it has a good Omnidirectional pattern overall this frequency range. The antenna is designed on FR4 substrate with 0.8 mm thickness and fed with 50 ohm microstrip line. The antenna has a compact size of 25mm × 34 mm.**

Index Terms: *UWB Antenna, Band-Rejected, Slot, Microstrip, Omnidirectional Pattern, group delay*

I. INTRIDUCTION

The applications of UWB antenna are in the medical imaging, high-accuracy radar, wall imaging and wireless communications [1]. The most important characteristics of these antennas are low cost, compact size and good Omnidirectional Pattern, therefore the monopole planar antennas are suitable for designing and fabrication [2], Group delay is the other important parameters in these antennas. The frequency range for UWB system will cause interference to the WLAN (wireless local network) systems in 5.15 - 5.825 GHz. In order to solve this problem, hemicycle shaped slot created on antenna. This slot caused band rejection in WLAN systems frequency range.

There are several band-rejected UWB antennas are designed, such as Planar Rectangular antenna [3], Novel Modified Planar monopole antenna [4], Aperture UWB antenna with triple band-rejected characteristic [5] and CPW-FED UWB antenna [6], which have been reported.

In this paper we propose a planar band-rejected antenna. We deliberate the performance of the antenna for varying slot radius and then show design process and results of simulation. In comparison to the Planar Rectangular antenna [3] our antenna has better Omnidirectional patterns both in E-plane and H-plane in different frequencies and is simpler or easier to fabricate also in comparison to CPW-FED UWB antenna [6] it is smaller. Another advantage of our design is it very low group delay overall UWB frequency range.

This paper is organized as follow. Section II presents the geometry of the proposed antenna and how to optimizing its band-rejected performance by varying some geometric parameters. Section III presents the result of some important features of this antenna and section IV concludes this paper.

II. DESIGN AND ANALYSIS

Fig.1 shows the geometry of the antenna. The antenna is designed on FR4 substrate with a relative dielectric constant of 4.4 and loss tangent of 0.02. The dimension of the substrate is 25 mm × 34 mm. the width of the 50 ohm microstrip feed line is 1 mm and the thickness of printed antenna is 0.1 mm on both sides. A rectangular whose size is 25 mm × 12 mm is constructed for ground plane. The location and size of the slot were shown in Fig. 1. The parameter R is inner radius of the slot. This parameter is optimized to achieve band-rejected function at 5-6 GHz. The proposed antenna is simulated using the Computer Simulation Technology (CST). To achieve the UWB antenna we tuning two important parameters (I) width of the feeding line and (II) width of ground plane.

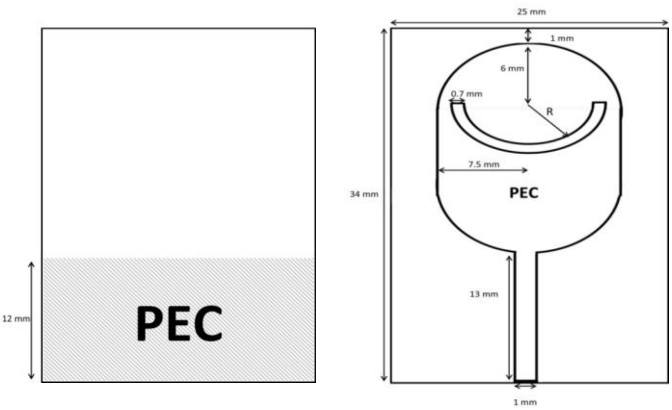

Fig. 1: Geometry of the proposed antenna

Fig. 2 shows the return loss of the proposed UWB antenna without hemicycle shaped slot. It is observed that the S_{11} parameter of the antenna is less than -10 dB entire UWB frequency range.

Fig. 3 shows the proposed antenna return losses for varying the inner radius of slot (R) from 4.6 mm to 5.2 mm. it shows the created slot result band rejection at a special frequency range. It is seen that, increasing the value of R has the effect of moving the center rejected frequency to left and also adjusting to WLAN in 5.15 - 5.825 GHz. It is observed that the value of R= 5 is optimal for covering WLAN system frequency range.

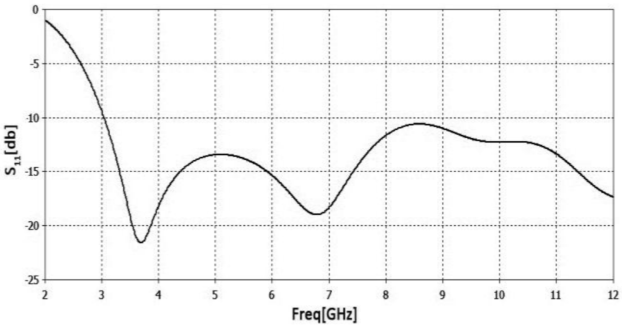

Fig. 2: simulated S_{11} in db for the antenna without slot

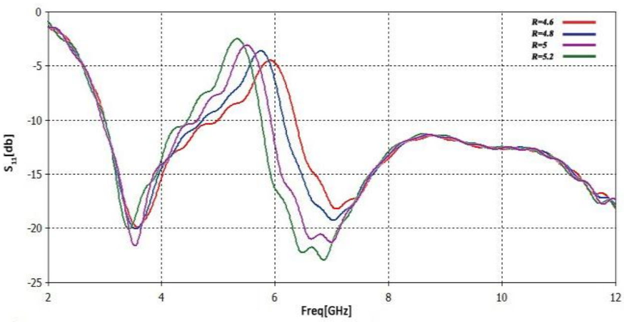

Fig. 3: simulated S_{11} in db for varying R from 4.6 mm to 5.2 mm. The optimal value is R=5

III. RESULTS

Fig. 4 shows the S_{11} parameter for optimized UWB antenna. It's observed that the antenna doesn't have electromagnetic interference with WLAN.

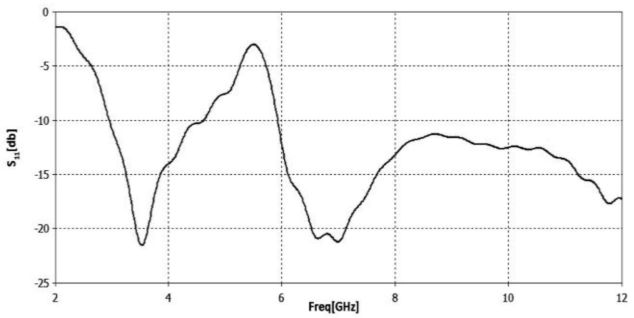

Fig. 4: S_{11} parameter for R=5 optimal value

Fig. 5 and 6 shows the Radiation Pattern at 3 GHz, 5GHz and 8GHz in the H-plane (XZ) and E-plane (YZ). The proposed antenna displays a very good Omnidirectional Radiation Pattern in XZ plane at different frequencies. The common problem in UWB antenna is great varying of the radiation pattern at different frequencies but in this figures we observe that these graphs are approximately similar in each planes.

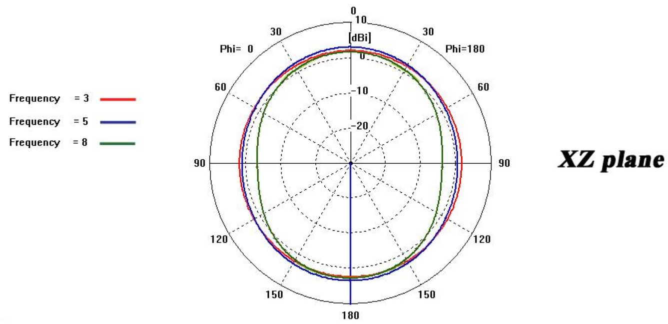

Fig. 5: Radiation Pattern for the antenna in XZ plane at 3GHz, 5GHz and 8 GHz

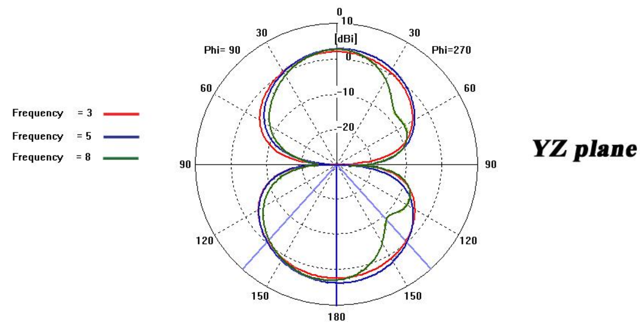

Fig. 6: Radiation Pattern for the antenna in YZ plane at 3GHz, 5GHz and 8 GHz

Fig. 7 displays the antenna gain in H plane. Decreasing at the 5.15 – 5.825 confirm performance of the band-rejected antenna. It also shows the antenna gain variations are less than 2 dB entire desired UWB frequency band that confirm good Omnidirectional pattern of the antenna.

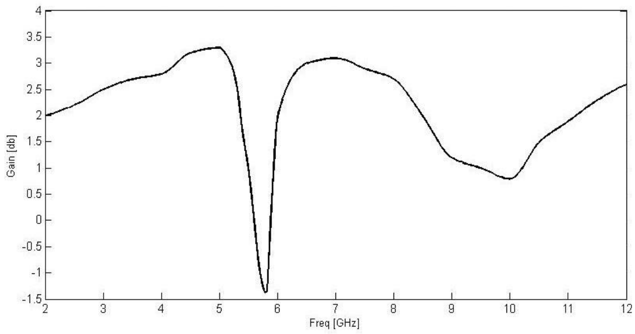

Fig. 7: Gain of the proposed antenna in XZ plane

To confirm the good operation of this antenna, it should have an adequate group delay parameter [7]. Group delay is defined as the derivative of the far-field phase with respect to the frequency which represents the distortion of pulse signal [8]. The group delay needs to be constant over the entire band to avoid undesirable distortion of the radiated and received pulse. Simulation result in fig. 8 shows the group delay is less than 0.5 ns. In comparison to [9] our design has better group delay characteristic.

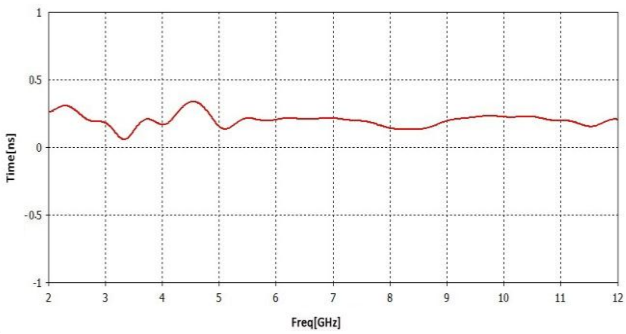

Fig. 8: Group delay of the antenna

IV. CONCLUSION

This work presents a simple structure of a compact UWB antenna with band-rejected property. The rejected-band is in 5.15-5.825 for WLAN system. To obtain it, a hemicycle shaped is created on antenna. The characteristics of this antenna are good Omnidirectional pattern in different frequencies, constant group delay over the entire band and easy to fabricate. The antenna operates in 3 – 12 GHz which covers all the frequency range of UWB. The applications of this antenna are in the radars, special in ground penetrating radar (GPR), medical imaging and wireless communication. The main advantage of the proposed antenna is the stability of the pattern that it is an important feature of UWB antennas.

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