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A Compact UWB Slot Antenna for WiMAX and WLAN Applications

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Abstract: A compact UWB slot antenna for Bluetooth application is proposed. This slot antenna consists of a circular patch. A UWB slot antenna has designed for both Bluetooth and notch band. The spiral structures and split resonators are used to notch the WiMAX and WLAN at 3.5 GHZ and 5.8 GHz respectively. L-shaped stub of quarter wavelength useful for Bluetooth band. The octagon shape of the slot antenna and reflection coefficient of less than -10 dB is obtained for the proposed antenna.

Keyword: UWB slot antenna, Bluetooth, WiMAX, L-shaped tub, return loss

I. INTRODUCTION

UWB is now being an essential part in the field of communication and especially in antenna. UWB have been used for improved gain, wider impedance bandwidth, stable radiation pattern, robustness, and simplicity in design. Within this UWB range there is an existence of other frequency bands such as, WLAN and WiMAX. There is a possibility of interference of these frequency bands. So it is necessary to build an antenna to avoid these frequency bands. In order to exchange the data, Bluetooth can be used as standard wireless technology over short distance which operates in the range 2.4-2.484 GHz. Low profile and the ease of fabrication characteristic brings about Microstrip patch antennas usage for Bluetooth applications. The patch antenna has its disadvantages of low gain, low directivity etc. Because of this slot antenna is used mostly due to its high gain, high directivity etc. An H-shaped patch antenna has been used for Bluetooth applications [1]. Double layer stacked patch antenna has been used for WLAN and Bluetooth application. In order to have high gain of the antenna and enhancing bandwidth double layer substrate is used with an edge feed [2]. A compact dual band planar antenna is presented for Bluetooth application with quadruple band notch characteristics [9][10][12]. The slot antenna used resonant spiral structures for rejecting the quadruple bands [3]. It is necessary to create monopole planar antenna for Bluetooth/ 3G/ WiMAX and UWB applications with band notch characteristics [4] [7]. For various wireless applications, printed slot antenna with three extra bands are used. U-Shaped strips have used for GPS, GSM and Bluetooth bands [5][9][15]. A dualband notched UWB antenna can be designed for Bluetooth applications. In this method a micro strip feed patch and electromagnetically coupled parasitic patch with arc shaped strips are used to achieve Bluetooth and UWB performance [6][11]. This antenna consists of a spiral structure for notching the frequency for WiMAX and split ring resonators for notching the band for WLAN [8][16]. For creating a Bluetooth band L- shape stub of quarter wavelength is used [14].

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II. ANTENNA DESIGN

The patch is printed on a FR-4 material with a size of $25x28mm^2$, thickness of 2mm, relative permittivity 4.4 and loss tangent 0.02. The proposed slot antenna geometry is shown in figure 1.

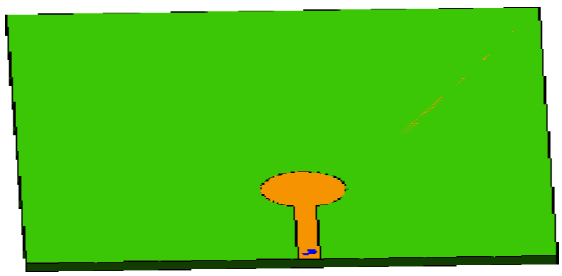

Fig. 1 view of slot antenna

Since Bluetooth operating frequency is 2.4 GHz so it cannot work under the UWB range. So at this low frequency band UWB is inactive. The slot antenna is the shape of octagon and is fed by a circular patch. To provide band notch characteristic split ring resonators are introduced [17]

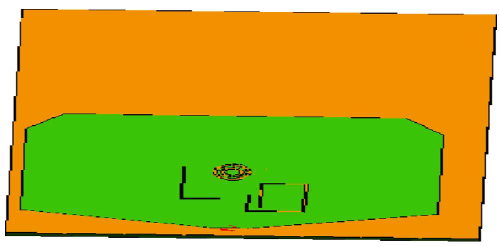

Fig. 2 Bottom view of slot antenna

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The split ring resonator is used to notch the frequency centered at 5.8 GHz for WLAN. A patch antenna used here operates over the UWB frequency range. In order to provide the required response for the stub the patch antenna can be used as ground plane. For creating a Bluetooth band L-shape stub of quarter wavelength is used. To notch a frequency centered at 3.5 GHz for WiMAX resonant spiral structure is used. This spiral structure is placed near the feed line in the ground plane to have better impedance matching and is fed from high current area.

III. WIMAX AND WLAN FOR UWB APPLICATIONS

Speedy development in technology throughout the world, ultra-wideband (UWB) reception apparatuses got extraordinary consideration in light of the fact that they have gigantic focal points, for example, high speed, straightforward assembling, little size, low power utilization [21][22][23] , less complexity, security, less obstruction, minimal effort and low profile [24] [25]. It is utilized as a major aspect of different applications, for instance, radar, images in the correspondence of medications and military. Links that get UWB must be non-dispersive or dispersive in a controlled way and satisfactory for compensation. Ultra-wideband (UWB) development is as of now spreading in a few zones, for example, compass radars, radiometers, radio star perceptions, repeat bounces, scattering reach and OFDM remote mapping out-lines, check outlines and direct essentialness [26]. The UWB settle beneficiary links could be arranged with different geometries; that is rectangular, triangular, circle, square and so on [27]. The desired antenna for a specific agenda relies upon the kind of use, recurrence, pick up, and so on. In many applications, the antennas are micro-strip antennas, planar antennas, monopole antennas, dielectric resonators etc. [28], due to its position of safety. These antennas have a wide application in versatile frameworks, WLAN with 5GHz band, WiMAX with 3.5 GHz band, ultra-wide band (UWB) with band 3.1 - 10.6GHz [29].

Today, these antennas wound up noticeably well known, so the specialists concentrated for the most part on them [30]. Among all the antennas, they lean toward the UWB since it can wipe out similar frequencies if there should arise an occurrence of impedance [22]. This end should be possible by making openings in various positions, for example like patch, feed and ground plane [31]. To build the data transfer capacity and proficiency of the UWB antenna [32], corner cuts, two openings in the patch and feed are made. Here in this proposition, two band dismissals are made at frequencies of 3.3-3.7 GHz and 5.15-5.825 GHz.

IV. RESULTS AND DISCUSSION

Return Loss

Reflected power from the antenna is represented as S11 parameter and it is also known as reflection coefficient or return loss. If S11=-10dB, that implies that 3 dB of power is delivered to the antenna, -7 dB is the reflected power. In telecommunications, return loss is a signal reflection by a irregularities or device insertion in a transmission channel which leads to impedance mismatch and usually expressed as decibels (dB) [19]. The simulated result shows that matching is perfectly done, since the return loss is -11.8 dB.

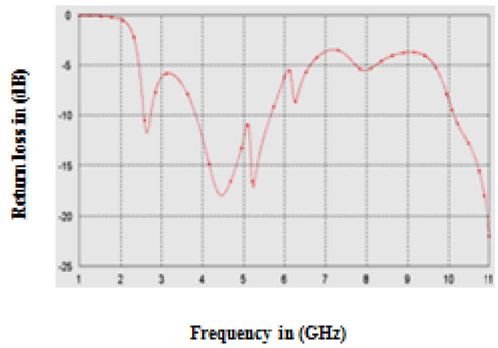

Fig. 3 Simulated Return Loss of the UWB slot antenna

Gain

Antenna gain is the ratio of the power transmitted by the antenna from a far-field to the power transmitted by a hypothetical lossless isotropic antenna [20]. Capability of antenna is to direct or concentrate RF energy in a particular direction. It is calculated in decibels relative to an isotropic radiator (dBi).

Antenna gain is referred to the radiation of ideal isotropic antenna which radiates the signals equally in all directions. igh gain antennas must have narrow bands in which the gain escribes the effective antenna that converts input power into radio waves in the desired direction.

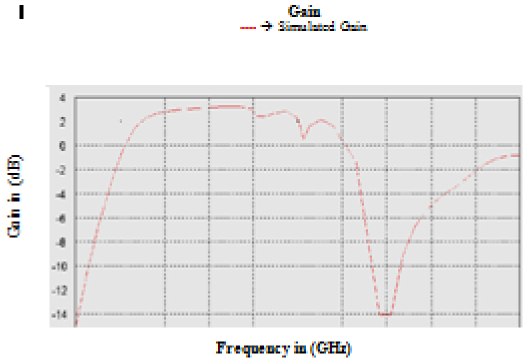

Fig. 4 Gain of the proposed UWB slot antenna.

Figure 4 shows that the peak gains of the proposed UWB antenna. From the simulation result, the gain of the antenna is found to be 2.33 dB. Spiral structure is initiated to create a notch centered at 3.5 GHz for WiMAX.

Directivity

Peak directivity (or simply directivity) is the ratio of the power density of the physical antenna in its most concentrated direction to that of a theoretical isotropic emitter of the same total power transmission level. D=10×Log10 (actual antenna isotropic antenna). Directivity is expressed as an ordinary number representing the ratio or in dB, with larger numbers representing more focused beams. An antenna that radiated equally well in all directions would have a directivity of 1 (0 dB).

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The Hertzian dipole presented earlier has a directivity of 1.5 (1.76 dB), owing to the lack of energy transmitted in the z-direction. Antennas can be used in different applications based on their directivity:

- Low-directivity antennas transmit and receive information from all directions more or less equally. These are useful in mobile applications where the direction between transmitter and receiver can change.
- High-directivity antennas are able to transmit and receive information over greater distances but must be aimed towards another antenna. They are used in permanent installations such as satellite television.

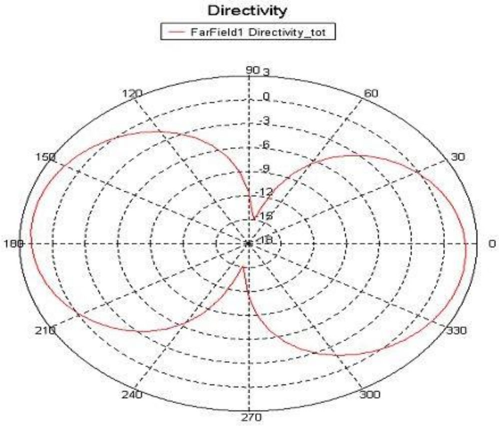

Fig. 5 Directivity of UWB slot antenna in polar plot

The UWB slot antenna has simulated directivity value of 2.92 dB and impedance bandwidth of patch fed slot antenna is existing in the range of 3.1-10.6 GHz. The Bluetooth band and split ring resonators have little effect on each other even though they are operating independently.

Table. 1 Parameters of antenna design

parameter	value in dB (simulated)	value (measured)
s11	-11.8	-11.8
Gain	2.33	4.97
Directivity	2.92	5.78

Radiation Pattern

Antenna performance can also be explored from the radiation patterns. The radiation pattern is graphical representation of the radiation properties i.e. field strength of the antenna as a function of space coordinates. The radiation patterns are E- and H-field pattern with respect to the field strengths. The animation above shows contours of constant radiation power density, propagating outward with time, traced in a plane that passes through a vertically oriented dipole antenna [13]. This is a two-dimensional slice of a three-dimensional radiation pattern.

Due to complexity, generally only a single contour (isoline or isosurface) is traced around an antenna to show far-field radiation patterns. The contour surfaces are centered on an antenna and the contour lines are centered on orthogonal planes that intersect the antenna, often around a line of symmetry. The Hertzian dipole above transmits very little to no energy in the vertical direction. Different antenna designs produce different radiation patterns. The complexity of the pattern depends on the antenna's design and construction.

The radiation pattern of the proposed antenna is shown in figure 6. Antenna specification sheets sometimes come with three-dimensional projections.

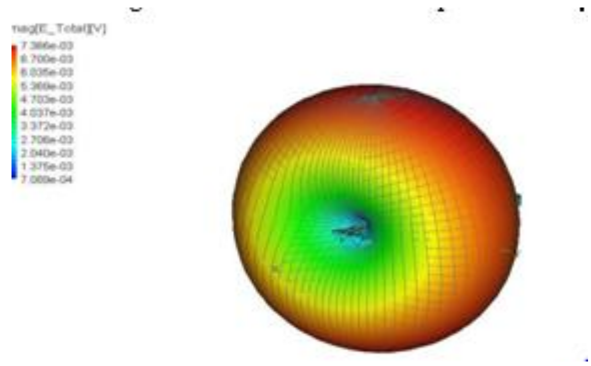

Fig. 6 Radiation pattern of UWB slot antenna in polar plot

More often, we see a two-dimensional plot and must imagine the three-dimensional pattern. The field pattern of the UWB slot antenna is shown in figure 7. The E-field pattern of the proposed antenna is measured in polar plot. There may be two types antennas like electric and magnetic. These are characterized by intense electric and magnetic fields very close to the antenna. Dipoles and horns are referred to electric antennas where loops and slots antennas are best examples of magnetic antenna. These antennas are characterized by high radiation intensity and directivity. The bottleneck of electric antennas has more interference in near field than magnetic antennas. Thus, magnetic antennas are more advantageous for embedded antennas than electric antennas.

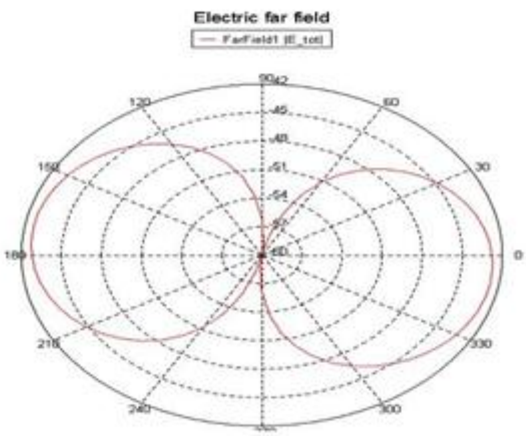

Fig. 7 Electric far field of UWB slot antenna in polar plot

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V. CONCLUSION

The slot antenna for Bluetooth applications with notch bands is designed. The stubs attached works on the Bluetooth frequency. Complementary split ring resonators and Bluetooth band works independently. The designed antenna provides a stable radiation pattern.

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