A Survey on Microstrip Patch Antenna Having WLAN and WiMAX Band Rejection

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Abstract: **To enhance the performance, various methods have been applied to design the antenna. Still the scope remains unchanged in antenna research. Microstrip Patch Antenna has a prime role in wireless communication. In recent years, researchers have focused on improvement of the UWB antennas. UWB has attractive merits compact size, low cost, resistant to severe multipath and jamming, ease of fabrication, and good omnidirectional radiation characteristics.**

Key Words**: Microstrip patch Antenna, WLAN, WiMAX Antenna, band rejected antenna, UWB**

I. INTRODUCTION

Microstrip antenna are popular for their attractive features of planar antennas such as low profile, light weight, conformal shaping, low cost, simplicity of manufacture and easy integration to circuits, and their use in dual frequency band applications appears very attractive [1]. Nowadays, in order to satisfy the ever-growing requirements of miniaturized size, multiband, and omnidirectional pattern antenna for multisystem, a great number of significant researches and designs have been undertaken, especially for the Wireless Local Area Network (WLAN: 2.4–2.48, 5.15–5.35, and 5.72–5.85 GHz) and the Worldwide Interoperability for Microwave Access (WiMAX: 2.5–2.69, 3.40–3.69, and 5.25–5.85 GHz) in the modern communication systems. Compared with the broadband antenna, the multiband antenna can effectively filtrate the unnecessary bands which will reduce the system interference and complex for multimode operations.

As wireless applications continue to expand, antennas that can handle more than one frequency band are gaining in importance. For two of the more popular wireless frequency bands—those for Wi-Fi/WiMAX applications at 2.4 and 3.6 GHz—a microstrip patch antenna was developed in a compact size and with versatile frequency characteristics.

II.TECHNIQUES USED FOR WLAN AND WIMAX BAND REJECTION

In 2016 Sun Woong [2] has discussed, a insertion of λg/4 resonator and a C shaped slit into an antenna in order to reject both WiMAX and WLAN bands as shown in figure 1. To reject WiMAX a pair of λg/4 resonator is centred on the microstrip line and a C shaped slit is inserted into an elliptical patch as shown in figure 2. For the structure of the proposed antenna λg/4 resonator and a C shaped slit were inserted into an antenna. The antenna was designed with an elliptical patch structure, in order to reject WiMAX and WLAN.The antenna was fabricated using the Taconic TRF 45 substrate, which is 1.62 mm in thickness and offers a relative permittivity of 4.5 and loss tangent of 0.0035.The antenna is compact with a total size is 40x35 mm2.Two bands coexist for unlicsened use in the UWB WiMAX(3.3-3.8GHz) and WLAN(5.15-5.85GHz).The proposed antenna rejects both of these bands using a λg/4 resonator and a C-shaped slit.

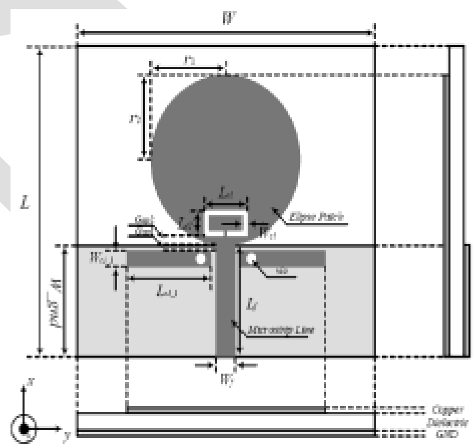


Figure 1 Structure of the proposed UWB monopole antenna with dual-band rejection.

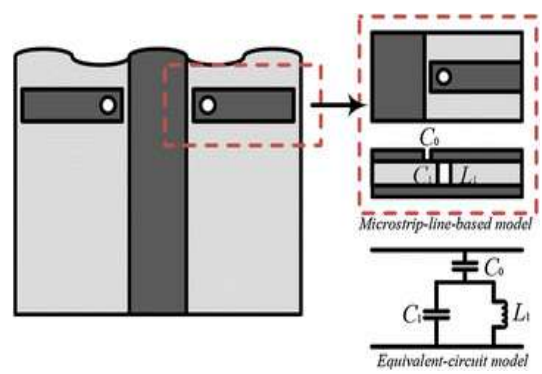


Figure 2:The mechanism of the proposed λg/4 resonator

In the other technique given by Monika Kunwal[3] in 2016.A novel and compact ultrawide band antenna has been proposed for triple band notched rejection as shown in figure 3.

The first rejection band is obtained by etching the C-shaped type slot in the partial ground structure. The second and last rejection bands are obtained by inserting the inverting and noninverting C-shaped type slots in the patch, respectively.

An antenna having three-stop band has been proposed. C-shaped type slot is embedded in the ground for eliminating band from 5.1 to 6.03 GHz and for eliminating band from 2.45 to 2.74 GHz and 3.41–3.75 GHz, inverted C-shaped type slot and C-shaped type slot are introduced in the patch.

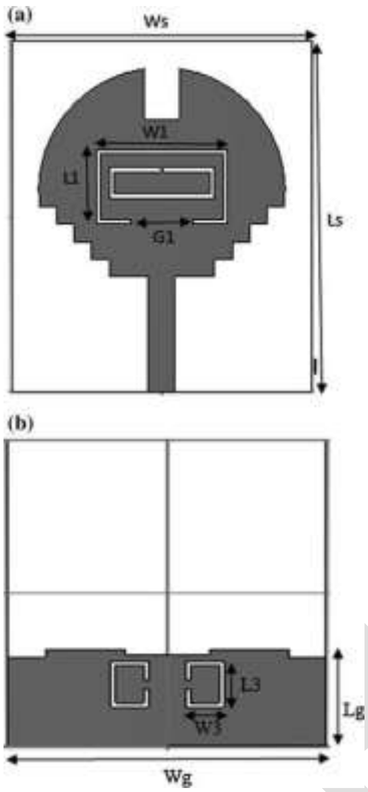


Figure. 3 Configuration of the desired antenna structure a Top view b. Bottom view

The impedance bandwidth of the desired antenna is 2.34–10.5 GHz, for S11 ≤ −10 dB. There are three stop bands in the frequency ranges 2.43–2.62 GHz, 3.35–3.69 GHz, and 4.94–5.96 GHz, for VSWR > 2. Therefore, these stop bands are used to avoid interference with 2.5 or 3.5 GHz WiMAX and 5.5 GHz WLAN band.

In 2015 Pankaj Dhakar [4] gives a technique for dual band rejection for WiMAX AND WLAN application using microstrip feed small square UWB antenna as shown in Figure 4. In this antenna FR4 substrate of thickness 1.6 mm, permittivity of 4.4 and loss tangent of 0.025..it consists of square radiating patch with W- and O-shaped slots cut inside it, 50 Ω microstrip feed line printed on substrate and a partial ground plane with a pair of U-shaped slots printed on other side of substrate. The square patch has dimension of 8x8 mm2 and width Wf of microstrip feed line is fixed to 2 mm to achieve 50 Ω characteristics impedance over wide frequency range 3.05-14.l GHz.

It was observed that this antenna increase the impedance bandwidth to higher band a pair of U-shaped slots is inserted in the partial ground plane whereas to realize dual band rejection performance W- and O-shaped slot cut inside square radiating patch. The proposed antenna provides wide impedance bandwidth between 3.05-14.1 GHz with two rejection bands around 3.25--4.38 GHz and 5.11-5.88 GHz which cover 3.5/5.5-GHz WiMAX bands and 5.2/5.8-GHz WLAN bands respectively.

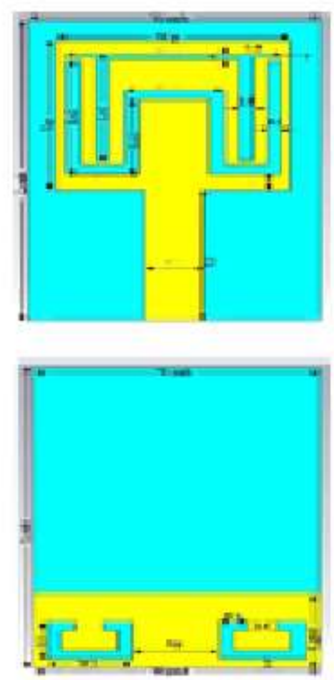


Figure 4. Geometry of Proposed Antenna

The optimal dimensions of the proposed antenna are as follows: Wsub = l0 mm, Lsub = 16 mm, Wf = 2, mm, Lf = 7 mm, Wgnd = 10 mm, Lgnd = 4 mm, Lp = 8, Wp = 8, Ll= 2 mm, W1= 3 mm, W2 = 1 mm, Gp= 3 mm, Ls1 = 5.7 mm, Ws1=7.4 mm, Ls2 = 6 mm, Ws2 = 2.5 mm, Ls3 = 4.5 mm, Ws3 = 3.4 mm G1 = 0.6 mm, x = 0.3 mm, y = 0.2 mm. Moreover, the structure of the antenna is symmetrical with respect to the longitudinal direction.

In 2014 Sreerag M [5] proposed a work for hexagonal boundary fractal antenna for WiMAX application as shown in figure 5.Band Rejection in WiMAX range of 3.4 to 3.6 GHz is achieved by etching slots on the radiating element. In this antenna FR4 substrate with relative permittivity of 4.4, a loss tangent of 0.02 and thickness of h 1.59 mm.The antenna consist of hexagonal fractal boundary as the radiator fed by a microstrip fed line.The dimension is 40×38 mm.For the hexagonal boundary centre hexagon of 6 mm size which is one third of the initiator, is etched out which acts as the first iteration. Additional four hexagon of one third size is subtracted to obtain the next iteration. Band rejection in

WiMAX frequency range is obtained by etching a split ring slot on the radiator as shown in figure 6.this antenna is used for gain enhancement upto 3.5dBi.

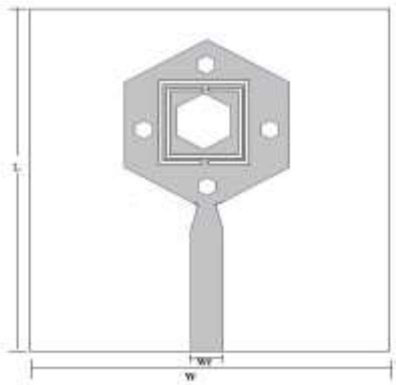


Figure 5 Antenna structure

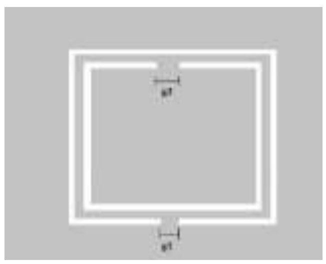
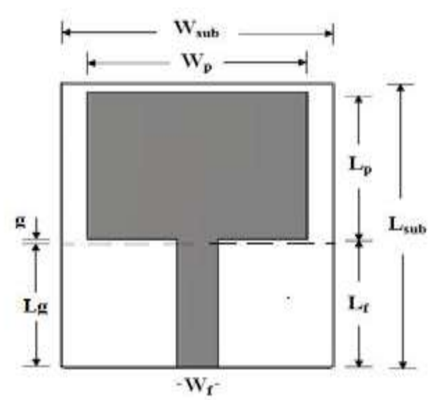


Figure 6 Slot for band rejection

In 2014 Jamal M Rasool and Ishan M.H. Abbas[6] has discussed a printed monopole antenna based on fractal structure depends on koch fractal type as shown in figure 7.A slot antenna has been proposed based on Koch curve used in ultra wide band application, slot of C shaped rotated with 90^o CW to reject the WiMAX band 3.4-3.69 GHz as shown in figure 8.It is printed on FR4 substrate of 4.4,dielectric constant 1.6 mm thickness and dimension is 20mm×25mm×1.6mm. it offers a bandwidth from 2.84 GHz to 13.28 GHz for return loss ≤ -10 dB.The microwave CST simulator is used for finding the result.It was observed from this antenna that a C shaped slot in the upper portion of the radiating patch to reject the band for WiMAX band.it is used in mobile and portable devices in wireless communication applications.



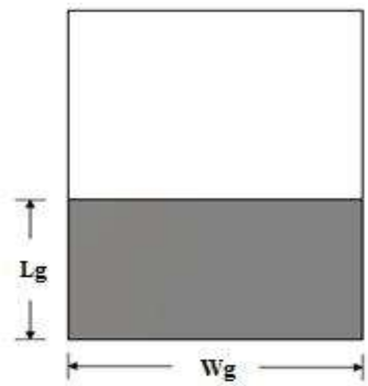


Figure7 The geometry of the printer monopole (a) Front view, (b) Back view

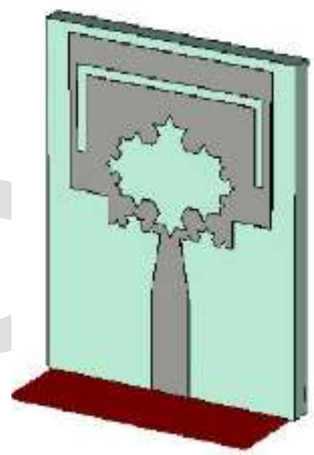


Figure 8 The geometry of the proposed printed monopole Notched-band UWB antenna

In 2010 ShunYun Lin and Bi Jin Ke [7] gives another technique band rejected characteristic in printed microstrip antenna.The proposed antenna was with a rectangular patch fed by a microstrip line.The ground plane was printed on the opposite layer of the substrate.The patch was placed above a larger rectangular notch cut in the finite ground plane edge as shown in figure 9.Two folded strip with different length from the patch corner with null surface current.

To introduce dual rejected band.The longer strip and shorter strip are independently associated with lower and upper rejected band. A triband operation for 2.5/3.5/5.5 GHz WiMAX and 2.4/5.8/5.8 GHz WLAN is achieved for the proposed microstrip antenna. The FR4 substrate with relative permittivity 4.4.A 50Ω microstrip line with length of lf fed the radiating patch at the lower right edge.The Dimension is 40×20mm2 (L×W).It covers all the operating band of WLAN/WiMAX system and it is easy to fabricate on FR4 substrate. The dual band rejection is achieved owing to two strips from the non-radiating edge of patch and is suitable for mobile wireless devices.

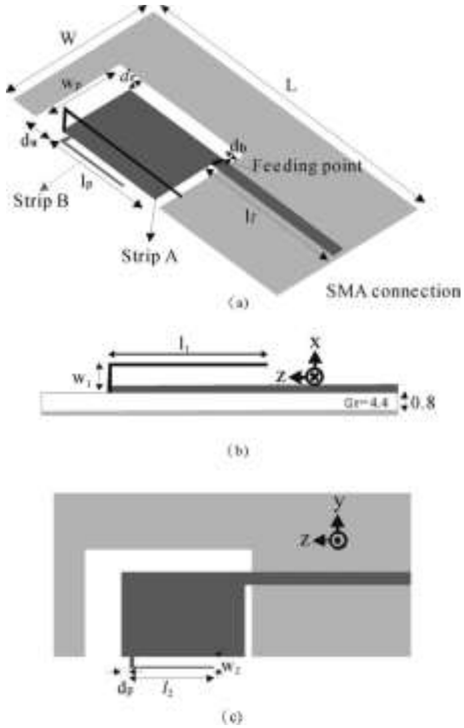


Figure 9: Configuration of the proposed UWB printed patch antenna, (b) side view of the design, (c) vertical view of the design

In 2008 Wen Shen Chen and Kuang –Yuan Ku[8] gives a novel design of the band rejected function by inserting strips on wideband printed open slot antenna, to reject single dual band operation as shown in figure 10.The FR4 substrate is used of thickness 0.8 and a relative permittivity 4.4.Antenna has a small size 30×35mm2 .For the band rejected function insert a strip on the open end by properly tuning the dimension of the strip[9].

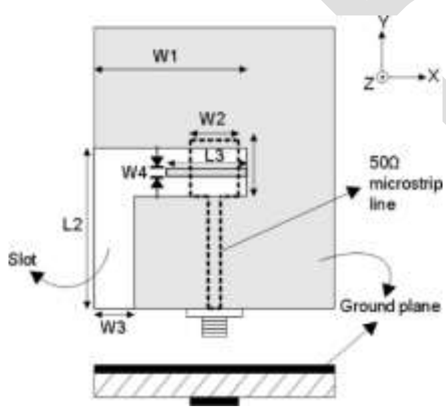


Figure 10 Geometry of the band-rejected open slot antenna for WLAN /WiMAXbands

It is observed that by inserting a strip on the printed slot antenna it rejects frequency 3.56 to 4.58 GHz and obtained for WLAN application. By further inserting strip, a three band antenna is achieved.

In 2014 Rezaul Azim[10] has discussed a technique that, a printed planar monopole antenna with a notched band to filter out the WiMAX frequency band.To achieve a notch band at 3.5 GHz, a parasitic element has been inserted in the same plane of the substrate along with the radiating patch as shown in figure 11. By properly adjusting the position of the parasitic element, the designed antenna can achieve an ultrawide operating band of 3.04 to 11 GHz with a notched band operating at 3.31–3.84 GHz. Moreover, the proposed antenna achieved a good gain except at the notched band and exhibits symmetric radiation patterns throughout the operating band. This antenna has a compact size and attain the stop band characteristic to lessen the interference between UWB and worldwide interoperability for microwave access (WiMAX) band.

The antenna is having a radiating element and a ground plane and is fed by microstrip feed line. The radiating element of size 13 ×7 mm2 is printed on one side of a substrate while the conducting ground plane with a wide tapered shaped slot is printed on the other side. FR4 with a thickness of 1.6 mm and dielectric constant of 4.6 is used to design the proposed band notch antenna. The 50Ω microstrip fed line has a width and length of 3 mm and 6 mm, respectively, and the gap between the ground plane and patch is h = 0.75 mm.

To notch the WiMAX frequency band, a parasitic element (filter element) has been etched on the same side of the substrate along with the radiating element as shown in Figure 10.

To achieve a desired stop band in order to minimize the potential interference between WiMAX and UWB a parasitic element has been introduced along with the radiating element. It is used in different wireless communication.

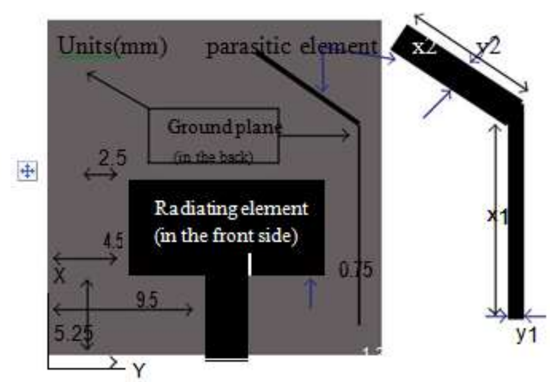


Figure 11: Geometry of the proposed antenna

In 2015 Swarap Das[11]designed a UWB planar monopole antenna with etched spiral slots on the patch for single,double and triple notched band.It can notched with central frequency 3.57,5.12,8.21 GHz by varying the length of a single spiral slot. According to IEEE 802.11standard WLAN in the frequency band of 5.15-5.35GHz and WiMAX 3.5 GHz around to avoid the potential interference frequency band. A single spiral slot has been used to generate single, double, and also triple notched bands by varying spiral slot length with central frequency of 3.57, 5.12,and 8.21 GHz, respectively. It provides a simple and compact realization with stable radiation performance of a triple band-notched planar antenna suitable for UWB applications.

A spiral slot loaded with single notch is shown in Figure 12.The antenna is printed on the top of a light weight. The FR4 substrate εr=4.4,tan δ =0.02,thickness h=1.6mm.The length(L) and width(W) are 30 mm each.The feed line 50Ω CPW is connected to the radiating element.To reject the interference with existing wireless band, a thin spiral slot has been printed on the radiating patch as a half guide wavelength resonator to generate the notched band.The spiral slot is etched with a width of 0.5 mm to produce strong resonance that guarantees better band rejected performance.

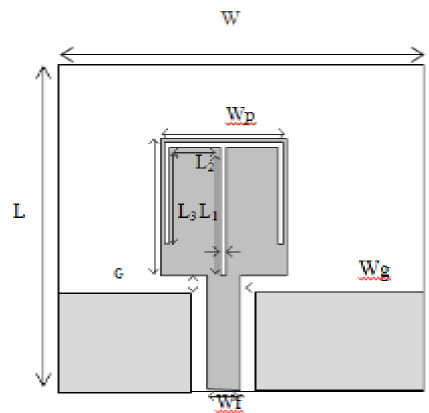


Figure 12: CPW fed planar monopole antenna with single notch

On the same structure if the slot length has been increased 14 mm on both sides which gives dual notch. The gap between two slot is kept at Ms=0.25 mm.This structure as shown in figure 13.

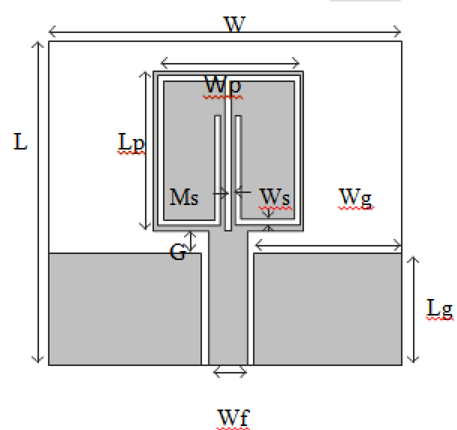


Figure 13: CPW fed planar monopole antenna with double notch.

On the same structure described previously if the slot length has been increased 35.4375mm on both sides it gives triple notch at desired frequencies.The gap between two slot is kept Ms=0.25 mm. as shown in figure 14.

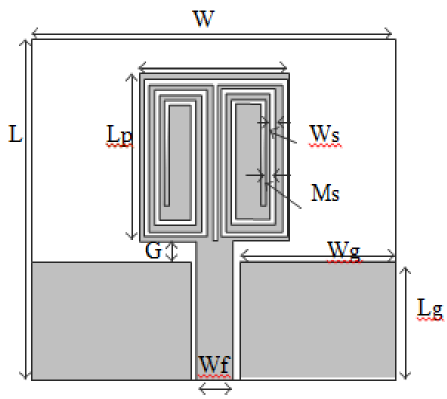
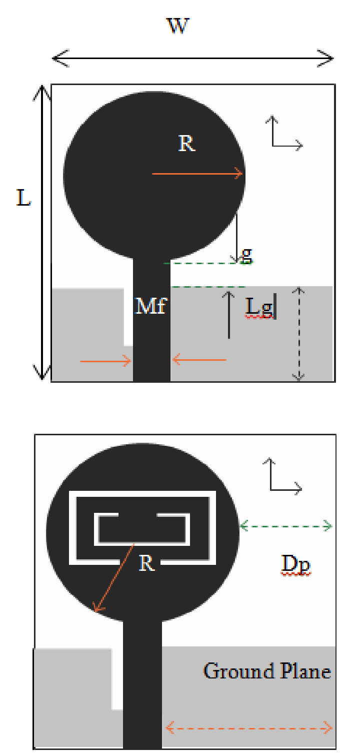


Figure 14: CPW fed planar monopole antenna with triple notch.

In the other technique given by M M Islam[12],a band removal property using complementary split ring resonator(CSRR) is applied to design a compact UWB for rejected 5.5 GHz WLAN band as shown in figure 15. The mentioned band- rejected antenna is made of circular radiating patch with complementary SRRs slots and a partial ground plane containing a rectangular slot on the upper portion, generating an ultra wide bandwidth ranging from 3.45 to more than 12 GHz.This antenna rejected a 5.5 GHz WLAN band UWB antenna. The dielectric constant is 4.6 and loss tangent of 0.02.it is performed on HFSS based on finite element method. . The antenna is composed of a circular patch and a partial ground with a thorough size of 22 × 26 mm.The slotted CSRR are inserted in the circular patch to observe notched 5.5 GHz WLAN band.



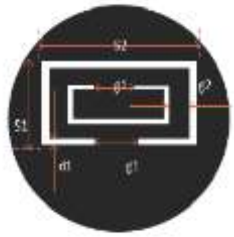


Figure 15: Structures of the (a) UWB antenna, (b) proposed band-rejected antenna, and (c) band-rejection layout

In another technique given by M Samsuzzaman[13] a compact modified Swastika shape multiband patch antenna as shown in figure 16.It consist of a planar wide square slot in the ground with four slits and Swastika shape radiation patch with a rectangular slot.it is analysed by using HFSS method.The slots and slits in the ground plane are expanding the surface current. Three resonant modes with good impedance performance are achieved. The measured −10 dB impedance bandwidth of the proposed antenna covers 2.28–3.23 GHz, 3.28–3.94 GHz, and 4.76–6.55 GHz, which meets the specifications of WLAN2.4/5.2/5.8 GHz and WiMAX 2.5/3.5/5.5 GHz bands.The antenna is fabricated on a 1.6mm thick FR4 substrate with a permittivity of 4.6 and a loss tangent of 0.02. The overall size of the antenna is 40×40×1.6 mm3.The main resonator element of the antenna is the swastika shaped mono pole element designed to operate at center frequency 3.5 GHz.The wide square slot in the middle is responsible for lower band only.The other four slit is attached in the slotted ground plane.It is responsible for lower and upper operating band. The antenna dimensions are optimized using the commercially available simulation software of HFSS 15.0. The proposed antenna would be a good candidate for WLAN/WiMAX wireless communication system.

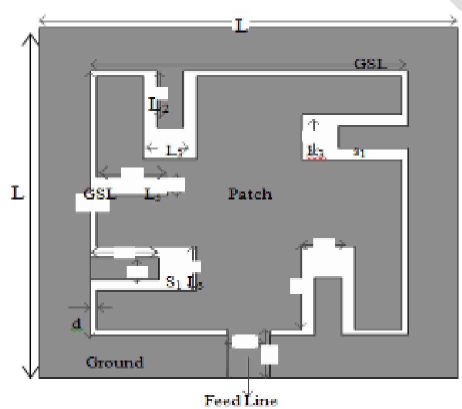


Figure 16: Proposed antenna geometry

In 2011 H.chen proposed an another technique for UWB antenna with WiMAX and WLAN band notched characterstic [14].It consist of a planar ellipse monopole UWB antenna fed by a CPW structure an arc shape on the monopole plate and a microstrip resonator on the other side of the antenna as shown in figure 17.The antenna having relative permittivity 4.4,thickness 1.6 mm and size is 35×30×1.6mm3.The arc slot on the planar ellipse radiation element achive the lower notched band (3.25-3.75 GHz) for WiMAX and for upper notched band(5.15-5.825 GHz) for WLAN.The microstrip resonator has the function of filter to the antenna by integrating the antenna and coupled microstrip resonator into a single module. The band rejection performance is realized by embedding an arc slot on the monopole plate and introducing the microstrip resonator. This antenna is used to reject interference.

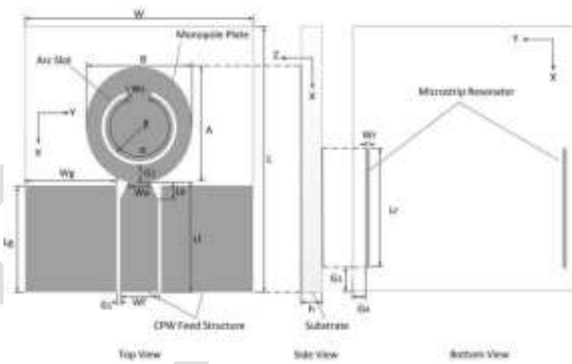


Figure 17: Proposed UWB antenna with dual notched band.

In 2015 Sanjiv Tomar[15] proposed a technique for a triple band notched UWB planar monopole antenna as shown in figure 18.The three notched band properties for WiMAX 3.3-3.7 GHz,WLAN 5.15-5.85 GHz,X band satellite communication 7.25-8.395 GHz.These band can be achieved by inserting U slot on the radiator patch,C slot also on the radiator patch and U slot on the microstrip feed line. The antenna having a size of 30×30 ×1.6mm3.The FR4 substrate of thickness 1.6 mm and a loss tangent if 0.02.The Radiator having 50 Ω microstrip line. To achieve wideband matching, a rectangular slot has been introduced in the ground plane just below the feed line.these notched band having a center frequency 3.5 GHz,5.5 GHz and 7.8 GHz can be achieved by using these slot.This antenna is used specially in miniaturization of modern communication devices like 4G mobile phones.

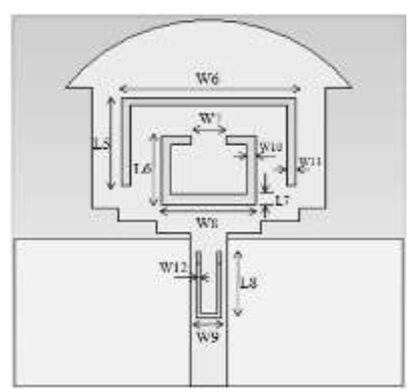


Figure 18: Configuration of proposed antenna

In 2016 Ahmad Zakaria Manouare[16]give another technique for triple wideband CPW fed patch antenna with a defected ground structure for WLAN/WiMAX application as shown in figure 19. It consist of a three radiating element with inverted L shaped stub 1,inverted L shaped stub 2,and a rectangular stub 3.The resonant frequency for WLAN 2.4/5.2/5.8 GHz and for WiMAX 2.5/3.5/5.5 GHz.The size of the antenna is 20×37 mm2 and relative permittivity is 3.66 and dielecric less tangent is 0.004.This antenna gives a reduction in size and weight and allows integration in handheld devices.The resonant frequency of WiMAX and WLAN can be tuned individually by adjusting the length of the three stubs.It is a good user for WLAN/WiMAX wireless communication devices.

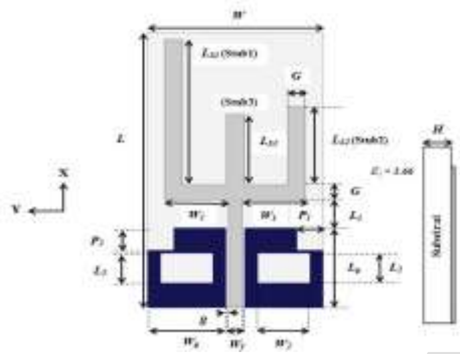


Figure 19: Geometry of the proposed antenna with defected ground structure

In 2015 Anil K. Gautam [17] gives a technique for a wideband antenna with defected ground plane for WLAN/WiMAX applications. This antenna uses an annular ring radiator which is encircled by a rhombus shaped strip and the defected ground plane on the other side of the dielectric substrate as shown in figure 20. A rectangular shape slot forms a defected ground structure.it can operate over the entire 2.4/5.2/5.8-GHz WLAN operating bands and 2.5/3.5/5.5-GHz WiMAX bands. The simulation of various parameters are conducted using Ansoft “HFSS” [18], a commercial electro- magnetic simulator based on a finite element method (FEM). The antenna having FR4 substrate with relative permittivity of 4.4, and a loss tangent of 0.02. The total size of the antenna is is 38 mm × 25 mm × 1.6 mm. The proposed antenna has several advantages, such as small size, excellent radiation patterns, and high gain which meets the requirements of WLAN/WiMAX applications.

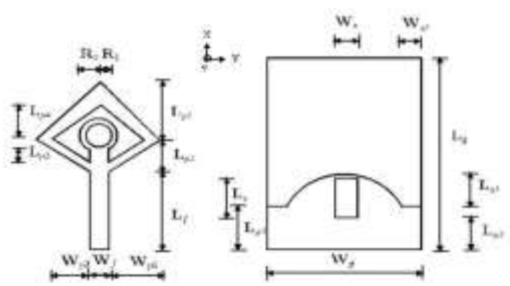


Figure 20: Schematic configuration of the proposed microstrip-fed wideband antenna.

III.CONCLUSION

Band Rejection of WiMAX and WLAN are the major design consideration.The rejected band and operating bandwidth can be easily adjusted for certain applications.Many designs of patch antennas are used to reject the frequency of WiMAX and WLAN.This paper shows the survey of various such methods of band rejection. With continuing advances being made to the patches and slots inserted into the antenna more work can be done in this area for achieving band rejection characteristic and its applications.

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