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A Survey on Wide Band Patch Antennas

*Rama Krishna Merugumalli**, *Appala Raju Kanakala*
Department of Electronics and Communication Engineering, Andhra Loyola Institute of Engineering and Technology, Vijayawada, India

Abstract
In this paper, the study of various solutions carried for wideband microstrip patch antenna is expressed. Little proficiency used for achieving more prominent bandwidth are analysed along with the mutual antenna conformation. Several techniques are likened in this.

Keywords: efficiency, gain, radiation pattern, slot, wideband (WB)

****Corresponding Author***
E-mail: ramakrishnamerugumalli@gmail.com

INTRODUCTION

In the present generation, the wireless communication devices have enhanced the demand of compressed wideband microstrip patch antenna. Small-sized antennas are used in movable communication system. Due to the lower volume and small size of microstrip antenna, they are used in greater extent in the systems. To achieve wideband, different techniques are carried like modifying the physical proportions of the antenna, coplanar wave guide (CPW) fed proficiency and modifying the pattern of ground plane.

METHODS APPLIED FOR WIDEBAND INCREASE

As shown in Figure 1 Mandal and Das[1] 2012 mentioned about hexagonal monopole antenna providing by a microstrip line for ultra-wide band (UWB) width. By the inverted U-shape slot in radiating patch the antenna is altered for band rejection at wireless local area network (WLAN) of frequency 5.15–5.88 GHz. As a consequence the value of impedance bandwidth is 10.04 GHz (3.11–13.15 GHz) and value of band stop is 5.15–5.88 GHz. The variation in peak gain is 1.53–4.05 dB in 2.74–11.05 GHz not including notch band of 4.95–5.92 GHz. In several communication applications with WLAN band elimination facility, these antennas are employed.

In other method imparted by Adnan *et al.*,[2] UWB applications are used with an antenna of circular printed monopole as shown in Figure 2.

As a conclusion of this, 120% bandwidth is attained by antenna with operating frequency varying from 3.1 to 11.5 GHz for 10 dB or less return loss.

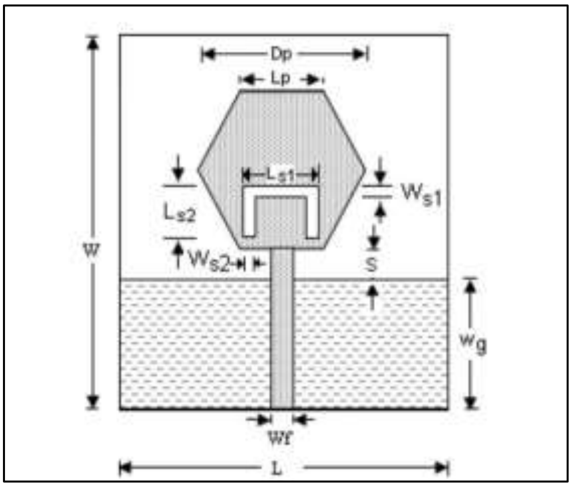

Fig. 1. *Configuration of U-Shaped Slot Hexagonal-Shaped Microstrip Antenna.*[1]

FR4 substrate with loss tangent of 0.02 was used for the fabrication of this antenna and dielectric constant (εr) is 4.4.

About 1.6 mm is the thickness of the fabricated subtrate with size of 34×36 mm^2, diameter of circular patch is 18 mm and width of transmission line changes. For simulation high-frequency simulation software (HFSS) is used.

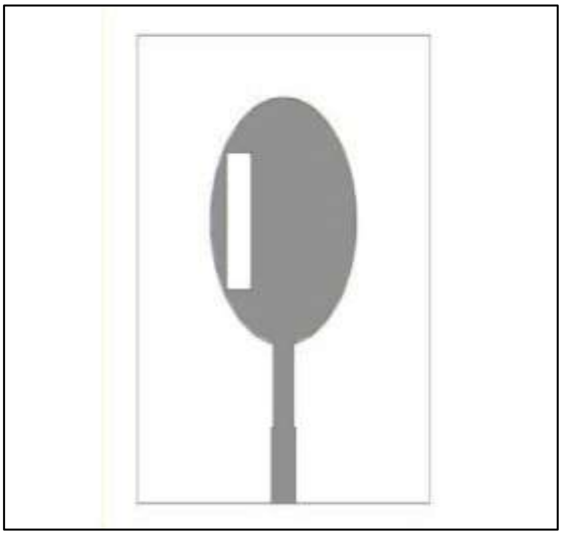

Fig. 2. *Geometry of Circular Printed UWB Microstrip Antenna.[2]*

Agrawal *et al*.[3] suggested other technique of hexagonal-shaped monopole fractal antenna in 2012 for UWB use. The frequency range of wideband is 2.64–6.96 GHz and bandwidth of 90%. The thickness of the dielectric substrate FR4 in antenna is 1.55 mm, relative permittivity of antenna is 4.4 and fed with microstrip line.

The results are found using EM simulator CST studio suite. At 6.5 GHz the best return loss of 35 dB is seen for this type of antenna. In this type of antenna, it is observed that impedance bandwidth is greatly affected by ground slot and the required frequency of band notch is produced by ground slit, which can be adjusted with the help of length of slit (Figure 3).

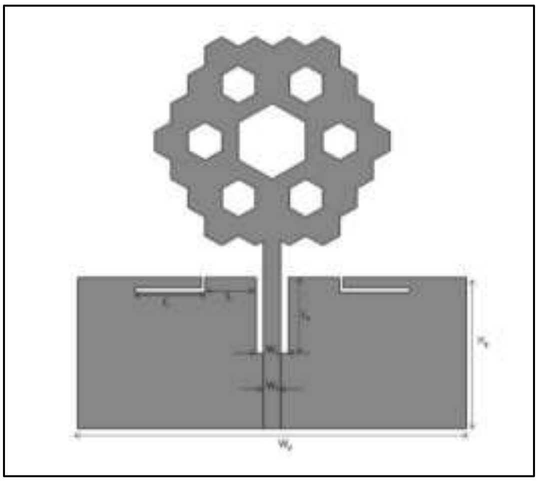

Fig. 3. *Geometry of Hexagonal-Shaped Fractal Antenna.[3]*

Jeevanandham *et al*.[4] projected another technique of dual-band circularly polarized hexagonal-shaped slot antenna in 2012, as shown in Figure 4. In this antenna, microstrip is fed with L-shaped stub. L-shaped slot and two slits are engaged to mend 3 dB axial ratio bandwidth to 4.5 GHz and impedance to 3.5. An impedance transformer is employed for better impedance matching of slot antenna in dual-band circularly polarized hexagonal antenna. In fabrication of slot, the FR4 substrate is employed. The results are good when compared with the measured antenna while simulated with a simulator. These types of antennas are utilized in the applications of wireless communication like WiMAX and WLAN.

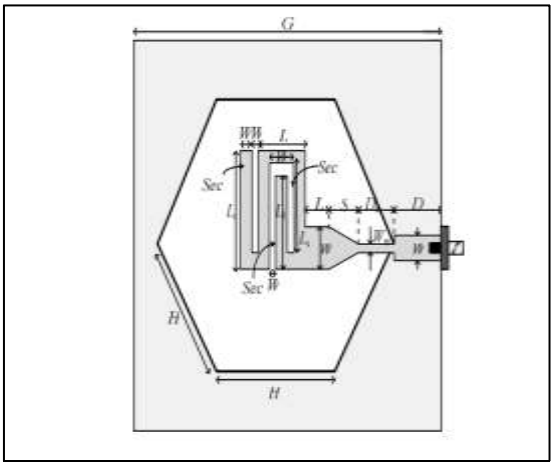

Fig. 4. *Geometry of Dual-Band Circularly Polarized Hexagonal Slot Antenna.[4]*

Mandal and Das[1] projected another method of printed regular hexagonal slot antenna served with a line of CPW which are used in UWB width (Figure 5).

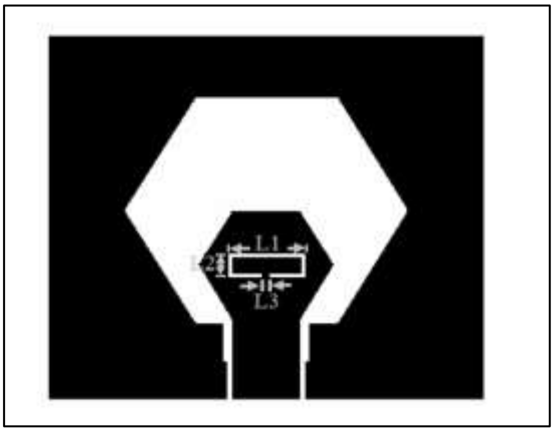

Fig. 5. *Configuration of Hexagonal Slot Antenna With C-Slot.[5]*

The usage of hexagonal shape stub is further changed for the rejection of special band at WLAN with a band of 5.1–5.8 GHz by a C-shape slot in the simulating stub. On observation, it is found that it has UWB with a frequency band of 6.5 GHz for VSWR ≤ 2 with WLAN band elimination in this type of antenna. The gain of this antenna changes between 4 and 5.3 dB in the total operating band except the notch band. In several UWB applications, this type of antenna works great.

Santawani and Suralkar[6] proposed other method of hexagonal-shaped patch antenna fed by CPW in 2015 as shown in Figure 6. The substrate used in this antenna has a dielectric constant 4.4, thickness 1.6 mm and depicts the maximum return loss value of –30.95 dB ranges, which from 2.9 to 12 GHz. These are used in UWB applications. The proportions of this antenna are $25.1 \times 20 \times 16$ mm^3, which shows that the antenna is having a very compact size. In this antenna, it has a hexagonal shape radiating element and inner slot with a rectangular cut. IE3D simulation software is used to find the results by simulation. We get an efficiency of 90% at 3.1 GHz frequency and an efficiency of 50–70% in the frequency range of 2.9–12 GHz. This shows that this antenna is relevant for UWB applications.

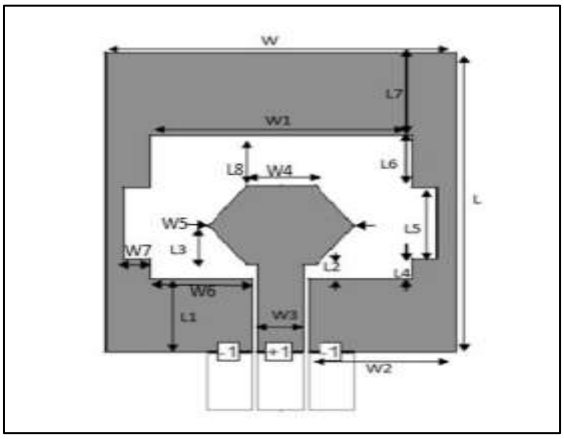

Fig. 6. *Configuration of Hexagonal-Shaped Antenna With CPW Feed.[6]*

Subbarao and Raghavan[7] proposed other method to find the triple band-notched characteristics of novel compact CPW-fed antenna in 2013 is as shown in the Figure 7. To prevent interference from WiMAX band it is engraved with a C-slot in novel patch. It has three erose bands of 3.3–3.7 GHz, 5–6 GHz, and 8–8.4 GHz in the band range of 2.8–11.2 GHz to reduce interference between WiMAX, ITU and WLAN at 8 GHz bands, in the order.

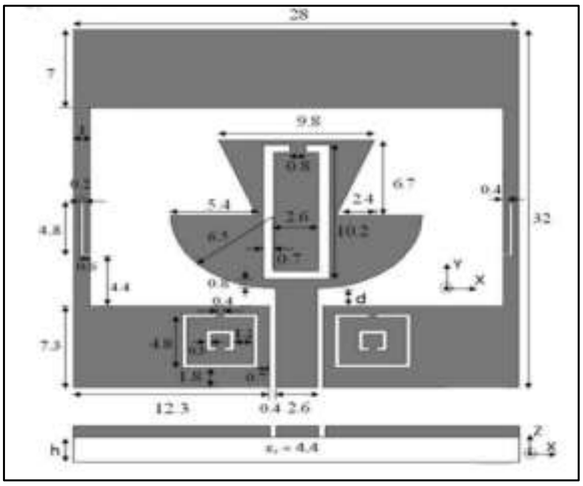

Fig. 7. *Configuration of Compact CPW Fed UWB Slot Antenna.*

Agilent E8363B is the network analyser which is used to measure the result and is examined with the help of IE3D electromagnetic simulator. Radiation patterns are found using the anechoic chamber. Stable Omni directional radiation patterns are seen in H-plane and bi-directional radiation patterns are seen in E-plane in this antenna. At 3.4, 5.5, and 8.2 GHz the effect of notched bands are seen due to sharp reduction in gain. So, they are used for anti-jamming. The first notched band is got by etching C-slot, second notched band is got by etching a pair of CSRR slots, and third notched bands are got by etching a pair of L-slits in radiating patch and ground plane. We can observe good impedance matching and also stable radiation patterns in this antenna. In this antenna measured results made a good grant with simulated results.

Zang and Wang[8] projected a technique of compact structure-shaped UWB antenna with a band notched characteristics (Figure 8). In this antenna, wide impedance bandwidth in the middle of 3–13.4 GHz and the loss less than −10 dB is accomplished by linking a radiating patch to microstrip and by amending ground plane. 3.4–3.7 GHz notch frequency band is attained with the usage of arc-shaped slot in the radiating patch. This antenna is printed on FR-4 substrate, which has a relative permittivity of 4.4, loss tangent of 0.02, and thickness of 1.4 mm.

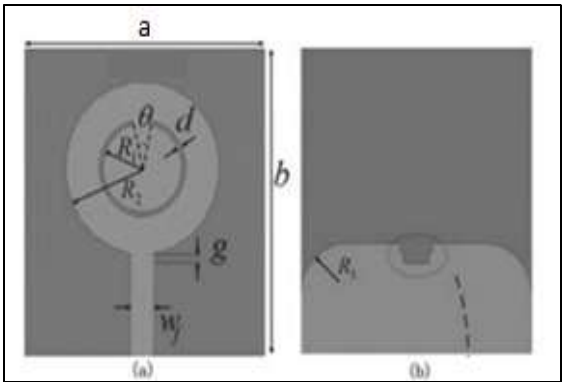

Fig. 8. *Geometry of Compact Circular UWB Antenna (a) Top View, (b) Bottom View.*

The microstrip feed line of the antenna has a width of 2.7 mm to get significant impedance of 50 Ω. Here, also HFSS is used to design and for optimization procedure. This antenna is applicable for UWB systems as the result of the antenna has a constant gain, stable radiation patterns and better impedance matching. Shi *et al*.[9] developed a new UWB antenna for dual band characteristics, whose structure is depicted in Figure 9. H-shaped slot on radiating patch with an arc removes first band. The narrow slots on ground removes second notched band. This UWB antenna operates over the range of 2.9–10 GHz, hence it can be used for WLAN (i.e., 5.1–5.9 GHz) and for WiMAX (3.3–3.6 GHz) applications. A 50 Ω CPW feed is applied to an antenna of 35.5×30×1.6 mm^3, fabricated on FR4 substrate. Because of WiMAX and WLAN bands rejection capability this model suits good for UWB applications with band rejection.

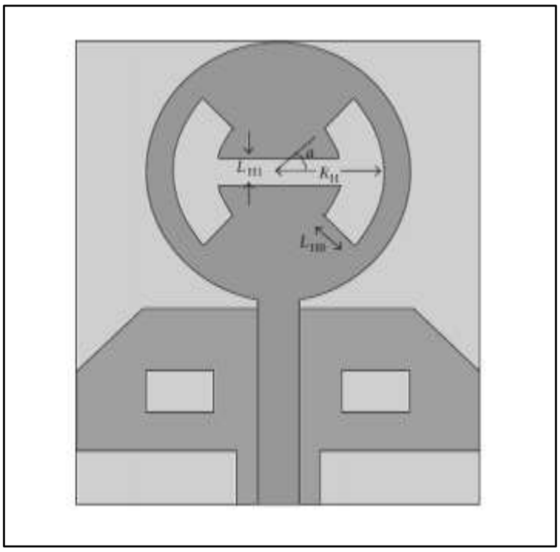

Fig. 9. *Geometry of the Arc H-shaped Slot.[9]*

Xu *et al*.[10] developed another model of UWB antenna operating at dual frequencies is shown in Figure 10. In this method, patch antenna is provided with two C-shaped slots. These will reject WiMAX (i.e. 3.38–3.82 GHz) and WLAN (5.3–5.8 GHz).

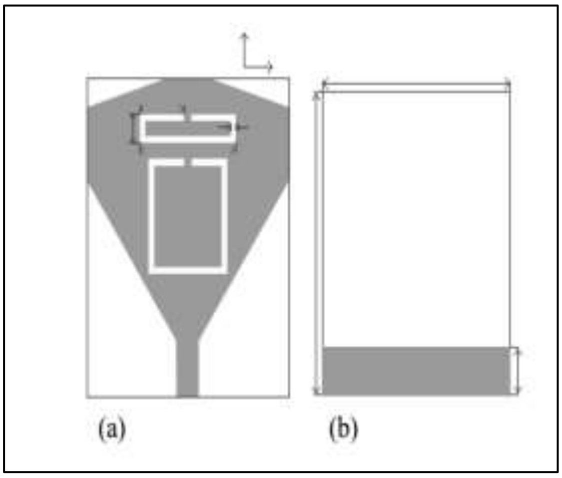

Fig. 10. *Geometry of Dual Band-Notched Antenna. (a) Top View, (b) Bottom View.[10]*

This arrangement is simulated in HFSS and CST, consequences attained are equated and attained good agreement. Due to its compact size (i.e. $22 \times 18 \times 1.5\ mm^3$) this can be easily fixed into portable UWB devices.

Gheethan and Anagnostou[11] developed a monopole antenna with 'A' shaped radiating antenna for UWB applications, as shown in Figure 11.

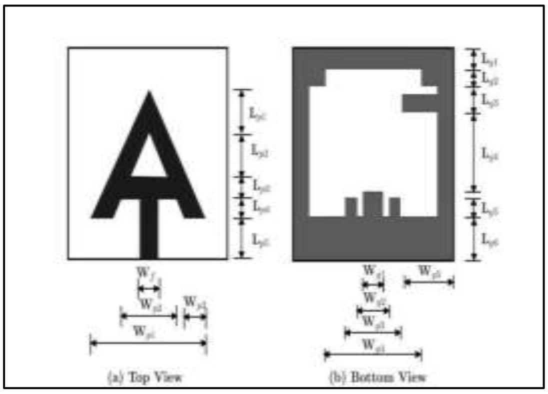

Fig. 11. *Schematic Configuration of A-Shaped Monopole Like Antenna.[11]*

This ground plane of an antenna has two rectangular slots of $16 \times 19\ mm^2$ and $11 \times 2\ mm^2$ and four rectangular stubs. A rectangular stub resonates at higher frequency, and ground plane resonates at lower frequency, which acts like a radiator. The antenna operates at 9.6 GHz with wide bandwidth of 2.9–11.5 GHz.[12–14]

CONCLUSION

A study of different techniques and designs proposed by various authors along with reference is presented.[15] It was found that some techniques are producing maximum band width but fail to have compact size (e.g. CPW technique produces maximum bandwidth without compact size).[16] To achieve wide bandwidth and compact size, many improvements should be made for better results.

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