IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 10, Issue 3, Ver. IV (May - Jun.2015), PP 01-05
www.iosrjournals.org

A Review on Microstrip Patch Antennas for WLAN and Wimax Applications

Amrutha.M.V, Manoj.K.C
PG Scholar, Dept. of ECE Vimal Jyothi Engineering College
Assistant Professor, Dept. of ECE Vimal Jyothi Engineering College

Abstract: *Wireless local area network (WLAN) and Worldwide Interoperability for Microwave Access(WiMAX) has been widely applied in mobile devices such as intelligent phones and handheld computers. For miniaturizing the wireless communication system the antenna which is being used must also be small enough to be placed inside the system. So microstrip antennas are becoming very popular in the field of mobile,radar,WiMAX,WiFi,LTE system, satellite,UWB etc .This paper presents a comparative study of microstrip patch antenna for WLAN and WiMAX application with changes in length and width of the patch, variety of substrates, feed techniques and slots. Here we also discuss the basics of microstrip antenna, antenna parameters,design models, various feeding techniques, with their advantages and disadvantages. A microstrip antenna is characterized by its length, width, gain, input impedance, and radiation pattern .The slot structure on the printed antenna that satisfies the requirements of the mobile WLAN and WiMAX applications such as the impedance bandwidth ,radiation pattern and gain is also presented. This paper in overall provides recent development, technologies and designs in the field of printed antennas for WLAN and WiMAX applications.*
Index Terms: *WLAN and WiMAX, microstrip patch, substrate, feeding techniques, bandwidth*

I. Introduction

As the communication devices are becoming smaller due to greater integration of electronics, the antenna becomes a significantly larger part of the overall package volume. This results in a demand for similar reductions in antenna size. When designed at lower microwave frequency spectrum,the size of a conventional microstrip antenna is somewhat large. Sometimes the size of the antenna even exceeds the dimension of the repeater or receiver system and thus is unsuitable for mounting conformably on the existing repeater/receiver system. For many antenna applications, such as handheld transceivers and handheld computers, small size is extremely important. For fixed wireless applications also, the small sized antennas plays an important role. The new trends in antenna design mainly focuses on the compactness of antenna,its robustness and integration with the existing RF circuit components. Antennas are basic components of any electric system and they are the connecting links between the transmitter and free space or free space and the receiver. Thus antennas play very important role in finding the characteristics of the system in which antennas are employed. Antennas are employed in different systems in different forms. That is, in some systems the high gain of the antenna is considered,or the directional properties,or the omnidirectional radiation pattern ,or the high beam width is considered.That is the selection of the antenna depends on its application.

II. Microstrip Antennas

A. Structure

A microstrip antenna in its simplest form consists of a radiating patch,which may be square or circular or rectangular in shape, on one side of a dielectric substrate and a ground plane on the other side. The radiating elements and the feed lines are usually photoetched on the dielectric substrate. The microstrip antenna radiates relatively broad beam broadside to the plane of substrate. Thus the microstrip antenna has a very low profile and can be fabricated using printed circuit technology. The radiating patch may be square, rectangular, thin strip (dipole), elliptical, triangular, circular,or any other configuration.

B. Feeding Techniques

A feedline is used to excite the antenna by direct or indirect contact. There are different techniques of feeding and four most popular techniques are coaxial probe feed, microstrip line, aperture coupling and proximity coupling. In microstrip feed technique, a conducting strip is connected directly to the edge of the microstrip patch. The conducting strip is smaller in width as compared to the patch .This type of feed arrangement has the advantage that the feed can be etched on the same substrate,so that it provides simple a planar structure.Microstrip line feed is one of the easier methods to fabricate because, it is a just conducting strip connecting to the patch and therefore can be considered as an extension of patch. The coaxial feed or probe feed is a very common technique used for feeding microstrip patch antennas. Coaxial feeding is feeding method in which the inner conductor of the coaxial is attached to the radiating patch of the antenna while the outer conductor is connected to the ground plane. Aperture coupling consist of two different substrates separated by a ground plane. On the bottom side of lower substrate there is a microstrip feed line whose energy is coupled to the patch through a slot on the ground plane separating these two substrates. This arrangement allows independent optimization of the feed mechanism and the radiating element. Normally top substrate is thick,and which is having a low dielectric constant while for the bottom substrate it is the high dielectric substrate. Proximity coupled type of feed technique is also called as the electromagnetic coupling scheme. The main advantage of this feed technique is that it eliminates spurious feed radiation and also it provides very high bandwidth (as high as 13%), due to overall increase in the thickness of the microstrip patch antenna.

C. Advantages of microstrip antenna

The antenna is broadly classified in two categories – unidirectional antenna and directional antenna. Most of the conventional antennas like yagi uda, helical, horn, parabolic etc are directional. They are quite good in terms of their bandwidth and gain. In spite of all these advantages they have some disadvantages.The disadvantages includes their large volume, very bulky structure, complex 3d structure etc. Microwave applications require small sized antennas so all these antennas are not well suited for microwave applications. Microstrip antenna is the one which is well suited for wireless and microwave applications. Compared with conventional antennas, microstrip patch antennas have more advantages and better performance. They are lighter in weight, low cost, low volume,low profile, smaller in dimension and ease of fabrication, simplified 2d structure and conformity. Moreover, the microstrip patch antennas can provide dual and circular polarizations, dual-frequency operation, broad band-width, feedline flexibility, beam scanning omnidirectional patterning and also high gain.

Microstrip antennas are extremely compatible for embedded antennas in handheld wireless devices such as pagers,cellular phones, etc. These low profile antennas are also useful in satellite,aircraft, and missile applications, where size, weight, cost, performance, ease of installation are considered. However, one of the major drawbacks of this microstrip patch antenna is the low bandwidth. Narrow bandwidth and gain are main disadvantages of this patch antenna. To overcome these disadvantages various techniques are used like varying the substrate thickness, changing the dielectric value of substrate, using the various patch configurations, using stacked configuration etc.

D. Disadvantages

Although patch antenna has numerous advantages, it has also some drawbacks such as narrow bandwidth, low gain, excitation of surface waves and a potential decrease in radiation pattern. Various techniques like using Frequency Selective Surface, Employing stacked configuration, using thicker profile for folded shorted patch antennas, slotted antennas like U-slot patch antennas together with shorted patch, double U-slot patch antenna, L-slot patch antenna, annular slot antenna, double C shaped patch antenna, E-shaped patch antenna, and feeding techniques like circular coaxial probe feed,L probe feed, proximity coupled feed are used to enhance bandwidth of patch antennas. The substrate height and dielectric constant of the substrate are very important factors that influence the changes of bandwidth as well as the surface waves. The substrates of dielectric constants are usually in the range of 2.2 to 12.The antennas with thick substrates whose dielectric constants are in the lower end of the range,provide better efficiency, larger bandwidth, loosely bound fields for radiation in the space and also it provides high gain.

III. Methods For Improving Bandwidth

The bandwidth of a dual patch antenna can be improved by etching dummy EBG pattern on the feedline. In spite of many advantages, these antennas suffer from some disadvantages which include their low efficiency, low power, poor polarization purity, spurious feed radiation and very narrow bandwidth . A possible way for increasing the bandwidth is to either increase the height of the dielectric or decrease the dielectric constant. However, the first approach would make it unsuitable for low profile structures while the latter approach will make the matching circuit to the patch difficult due to excessively wide feeding lines. Bandwidth of small size microstrip antennas has been improved by the use of U slot and L probe . By using compound techniques a new type of stacked microstrip patch antenna that increases the frequency bandwidth has also been studied. the bandwidth of an aperture coupled microstrip patch antenna has been improved by using an appropriate impedance-matching network using filter design techniques. The use of two triangular structures for microstrip patch antennas to improve the bandwidth has been studied. Unbalanced structures have also been used to design patch antennas to improve bandwidth. Performance parameters especially bandwidth, of patch antennas which are usually considered as narrowband antennas can be improved using metamaterial. Metamaterials are also the basis of further miniaturization of microwave antennas. The main interest behind using metamaterial substrate is :Increase bandwidth and gain of a patch antenna and Miniaturization of microstrip patch antenna.

IV. Comparison Table

Antenna	Author Name	Antenna parameter	Gain/BW	Structure	Size
rectangular microstrip slot antenna	Xu-bao Sun, Mao-yong Cao, Jian-jun Hao, Yin-jing Guo	RT/duroid 5880 , εr =2.2,h=1.6mm	36% fractional impedance bandwidth, centre frequency of 2.4 GHz	square slot and a rectangular slot	L1 = 76.4 mm, L2 = 46 mm, D1 = 30 mm, D2 = 6 mm, W2 = 10 mm, W1 = 1 mm.
dual-band patch antenna	A. Ameelia Roseline, K. Malathi	FR4, εr= 4.4,h=3.2 mm	1.8/2.4 GHz	slotted rectangular radiating element, spiral-like EBG.	60 mm ×60 mm ×3.27 mm
high gain microstrip antenna	applicationsKaushik Mandal, Partha Pratim Sarkar	glass-PTFE, h = 1.6 mm, εr= 2.4.	Gain 7.2 dBi	Six triangular slots	size60 mm × 50 mm.
Compact Printed Antenna	Barun Mazumdara, Ujjal Chakraborty	εr =4.4, h=1.5875 mm.	bandwidth of 15.58 MHz, return loss – 16.15 dB and bandwidth of 80.32 MHz, return loss - 15.05 dB	Two L slots	15mm x 12 mm
Broadband antenna	T.Shanmuganantham, S.Raghavan	εr =4.4 h=1.6mm	shows bandwidth improve- ment to 9.25%	U-shaped patch	14mm in width
CPW-fed antenna	M. Naser-Moghadasi, R. Sadeghzadeh	PCB εr =4.4 h=1 mm	1.60–1.85 and 4.95–5.80 GHz	Slotted patch	17mmx20mm
Duo Triangle Shaped antenna	Stuti Srivastavaa, Vinod Kumar Singha	εr =4.4 h=1.6mm	1.745-1.884GHz and 2.229-3.226 GHz	rectangle with cut corners-shaped ground	43.16 mmx35.51mm
circular microstrip patch antenna	P.V.Lokhande, B.T.Salokhe	FR4 εr =4.4 h=50 micron	2.45 GHz	Defected Ground Structure (DGS)	-
compact single probe-feed	Vivek Kumar Agarwala, Anand Kumar Shawa	FR4εr =4.4 h=1.6 mm	3.1 GHz and 5.5 GHz	rectengular microstrip patch	16 mm x 12 mm
Microstrip Antenna for WLAN	Rashid A. Saeed and Sabira Khatun	εr =4.4 h=1mm	80 MHZ bandwidth	slotted	-
Broadband antenna	Juhua Liu	εr =2.32 h=1.57	bandwidth of 12.48%	rectangular patch antenna, columns of shorting-vias	62.4mmx30.4mm
WLAN antenna	M. Z. A. Abd Aziz, Z. Zakaria	FR4,εr =4.4, h=1.6 mm	1.46dBi gain	with dual meander slot	-

Antenna	Author Name	Antenna parameter	Gain/BW	Structure	Size
microstrip antennas	Falguni Raval, Dr Y P Kosta	duroid substrate εr = 2.2 h= 1.6mm	design at frequency 10 GHz	Metamaterial as Defected ground plane	2.5mmx 3mm
rectangular patch antenna	Achmad Munir, Guntur Petrus	FR-4 εr =4.4 h= 1.6mm	center frequency around 1.6GHz	multiple slots etched on the patch	55mm x 80mm
array antenna	Chandan Kumar Ghosh1 and Susanta Kumar Parui2	RT/duroid εr = 2.2 h= 1.588 mm	bandwidth of 180MHz	slotted	18.8 mmx 24.4mm
rectangular microstrip	Mouloud Challal1,2, Arab Azrar1	RO4003C h= 1.524 mm	gain improvement of 0.8 dB	defected ground structure (DGS)	-
microstrip patch	Jaswinder Kaur*, Rajesh Khanna	-	Bandwidth= 219.2 MHz	co-axial fed single layer microstrip patch	16mm×21mm
Microstrip patch	Amit Kumar, Prof.P.R.Chadha	Rogers RT/ duroid 5880	-	U shaped patch	50mmx40mm
microstrip u-shape patch	Sanjeev dwivedi, R.N.Yadav	RT/duro5880 εr = 2.2	2.5 GHz	U shape patch	47.43 mmx 39.85mm
rectangular tri-band patch antenna	Gehan Sami a, Mahmoud Mohanna	Rogers RT/duroid, εr = 2.2,	5.8% impedance matching band width at 2.4 GHz	slotted	L =3.635 cm, W = 4.941 cm, H = 0.1588 cm
Wi-Max antena	Sukhbir Kumar1, Hitender Gupta	h=1.6 mm, εr =4.4 .	centred at frequency 5.25GHz	U-shaped slot	12.5 mmx 16 mm
patch antenna array	R. Jothi Chitra □, V. Nagarajan	FR4, εr= 4.4,	2.4/5.2/5.8 GHz	double L-slot microstrip	5.7mmx7.5mm
wideband microstrip patch	Gagandeep Kaur, Geetanjali Singla	FR4 substrate, εr= 4.4, h=1.6mm	bandwidth of 3.5 GHz	DGS	L=18.76mm, W=27.84mm

When rectangular slot is cut in the ground plane and the microstrip line is made perpendicular to it,then there occurs an increase in the bandwidth of the antenna.High bandwidth is obtained on the thin substrate,and this occurs because of the presence of the resonant modes created.RT duroid 5880 substrate with dielectric constant of 2.2 is used here.The duo triangular shaped patch antenna also provides high bandwidth.It makes use of the FR4 substrate with dielectric constant of 4.4 and thickness of 1.6mm.The circular microstrip antenna with DGS provides high bandwidth,in which the the shape defected in the ground structure will disturb the current distribution,and thus the excitation is effected and also the propagation of EM waves through the substrate layer.In the U slot patch antenna ,RT duroid 5880 with dielectric constant of 2.2 is used.In this ,the height of the substrate is varied and changes occurring in the bandwidth is observed.In the circular microstrip array antenna ,3 different substrate height and 3 different dielectric constants are considered.The change in the bandwidth is observed.High bandwidth is obtained for the thicker substrate.

Wireless communications have progressed very rapidly in recent years, and many mobile units are becoming smaller and smaller. To meet the miniaturization requirement, compact antennas are required in this field. Planar printed antennas have the attractive features of low profile, small size ,low volume and conformability to mounting hosts. The dielectric constant of the substrate is closely related to the size of the antenna and also the bandwidth. Low dielectric constant of the substrate produces larger bandwidth, while the high dielectric constant of the substrate results in smaller size of antenna. A trade-off relationship exists between antenna size and bandwidth.

substrate	Dielectric constant	Loss tangent
Bakelite	4.78	0.03045
FR4 Glass Epoxy	4.36	0.013
RO4003	3.4	0.002
Taconic TLC	3.2	0.002
RT Duroid	2.2	0.0004

V. Conclusion

The choice of an antenna for a particular frequency depends on following factors like radiation efficiency, antenna gain, radiation pattern,knowledge of antenna impendence for efficient matching of the feeder,frequency characteristics, bandwidth, and the structural considerations too. A theoretical survey on microstrip patch antenna is presented in this paper. After the study of various research papers, it is concluded that the bandwidth can be improved by various methods like changing the substrate thickness , by changing the dielectric constant of the substrate,by allowing slots in the patch,by using EBG structures and DGS etc. Microstrip patch antennas are well suited for wireless LAN application systems due to their low profile, conformability, low cost and low sensitivity to manufacturing tolerances. From the reference papers which are considered here,we could understand one thing that,the substrate thickness has influence on the bandwidth of the antenna.The aim of this project is to design efficient and reliable microstrip patch antennas showing high gain and wider bandwidth and which shows signs of directivity leading to adequate area coverage and sufficient bandwidth usage.

References

[1]. Xu-bao Sun, Mao-yong Cao, Jian-jun Hao, Yin-jing Guo,"A rectangular slot antenna with improved bandwidth", International Journal of Electronics andCommunications ,Vol.66,pp 465– 466 , 2012

[2]. Ameelia Roseline, K. Malathi,"Compact dual-band patch antenna using spiral shaped electromagnetic bandgap structures for high speed wireless networks", International Journal of Electronics andCommunications,vol.66, pp. 963– 968 2012

[3]. Kaushik Mandala, Partha Pratim Sarkar,"A compact high gain microstrip antenna for wireless applications" International Journal of Electronics and Communications,vol .67, pp. 1010– 1014 ,2013

[4]. Barun Mazumdara, Ujjal Chakrabortyb, Aritra bhowmikc, S.K.Chowdhuryd, "Design of Compact Printed Antenna forWiMAX & WLAN Applications ,Procedia Technology,vol.4, pp. 87 – 91, 2012

[5]. T.Shanmuganantham,S.Raghavan,"Designofacompactbroadbandmicrostrippatchantennawithprobefeeding for wireless applications", Int. J. Electron. Commun. (AEÜ) , vol. 63 ,pp.653–659 , 2009

[6]. M. Naser-Moghadasi, R. Sadeghzadeh, L. Asadpor, andB.S. Virdee,"A Small Dual-Band CPW-Fed MonopoleAntennafor GSM and WLAN Applications",,IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS,vol.12, pp. 508- 511, 2013

[7]. Stuti Srivastavaa, Vinod Kumar Singha, bAshutosh Kumar Singh and Zakir Alic,"Duo Triangle Shaped Microstrip PatchAntenna Analysis for WiMAX lower band Application", Procedia Technology, vol. 10, pp.554 – 563, 2013

[8]. P.V.Lokhande1, B.T.Salokhe,"Design & Simulation of Circular Microstrip Antenna with Defected Ground Structure (DGS) for WLAN Applications ",IOSR Journal of Electronicsl and Communication Engineering (IOSR-JECE) , pp.46-50

[9]. Vivek Kumar Agarwala, Anand Kumar Shawa ,"A Novel Compact Dual Frequency Microstrip Antenna", Procedia Technology, vol. 4, pp.427 – 430, 2012

[10]. Rashid A. Saeed and Sabira Khatun ," Design of Microstrip Antenna for WLAN ", Journal of Applied Sciences ,vol. 5 , pp. 47-51 , 2005

[11]. Juhua Liu, Quan Xue ,"Broadband Long Rectangular Patch Antenna With High Gain and Vertical Polarization ", IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, vol .61, pp. 539- 545, 2013

[12]. B. H. Ahmad1 M. Z. A. Abd Aziz," Investigation of dual and triple meander slot to microstrip patch antenna ",13th Conference on Microwave Techniques COMITE , 2013

[13]. Falguni Raval, Dr Y P Kosta, Jagruti Makwana, Amit V Patel,"Design & Implementation of Reduced size Microstrip Patch Antenna with Metamaterial Defected Ground Plane",International conference on Communication and Signal Processing, pp. 186-190 , 2013

[14]. Achmad Munir, Guntur Petrus, Hardi Nusantara ," Multiple Slots Technique for Bandwidth Enhancement of Microstrip Rectangular Patch Antenna", Quality in Research ,pp. 150- 154 , 2013

[15]. Chandan Kumar Ghosh and Susanta Kumar Parui ," Design, Analysis and Optimization of A Slotted Microstrip Patch Antenna Array at Frequency 5.25 GHz for WLAN-SDMA System", International Journal on Electrical Engineering and Informatics , vol .2, pp. 102- 111 , 2010

[16]. Mouloud Challal1, Arab Azrar1 and Mokrane Dehmas ," Rectangular Patch Antenna Performances Improvement Employing Slotted Rectangular shaped for WLAN Applications", IJCSI International Journal of Computer Science Issues , vol. 8, pp.254-258 , 2011

[17]. Jaswinder Kaur, Rajesh Khanna ," Co-axial Fed Rectangular Microstrip Patch Antenna for 5.2 GHz WLAN Application ", Universal Journal of Electrical and Electronic Engineering ,pp. 94-98 2013

[18]. Amit Kumar , Prof.P.R.Chadha ,"U Shaped Multiband Microstrip Patch Antenna For Wireless Communication System and Parametric Variational Analysis", IEEE ,vol .24, pp. 146-153, 2013

[19]. Gehan Sami a, Mahmoud Mohanna b, Mohamed L. Rabeh," Tri-band microstrip antenna design for wireless communication applications ", NRIAG Journal of Astronomy and Geophysics, vol .2, pp. 39–44 , 2013

[20]. Sukhbir Kumar, Hitender Gupta," Design and Study of Compact and Wideband Microstrip U-Slot Patch Antenna for Wi-Max Application', IOSR Journal of Electronics and Communication Engineering, vol. 5 ,pp.45-48 ,2013

[21]. R. Jothi Chitra ,V. Nagarajan," Double L-slot microstrip patch antenna array for WiMAX and WLAN applications ", Computers and Electrical Engineering , vol. 39, pp.1026–1041, 2013

[22]. Gagandeep Kaur Geetanjali Singla Simranjit Kaur ," Design of Wideband Micro strip Patch Antenna Using Defected Ground Structure for Wireless Applications", International Journal of Advanced Research in Computer Science and Software Engineering ,Vol. 3 , pp.762- 764 , 2013

[23]. [23] Trasma Yunita, Koredianto Usman," Experiment of Slotted Triangular Triple-Band Antenna for WiMAX/WLAN Application in Indonesia ", 7th International Conference on Telecommunication System Services and Applications (TSSA), pp. 300- 304 , 2012

[24]. Ram Singh Kushwaha , D.K.Srivastava , J.P.Saini ,"A Design of H-shape Slot loaded Wideband Microstrip Patch Antenna", International Journal of Electronics and Computer Science Engineering, pp. 533-537 ,2011

[25]. Md. Rabiul Hasan, 2Abdulla Al Suman ," Substrate Height and Dielectric Constant Dependent Performance of Circular Micro Strip Patch Array Antennas for Broadband Wireless Access ", Journal of Emerging Trends in Computing and Information Sciences, vol. 3, pp. 1392-1396.,2011