An Extensive Literature Review on Microstrip Antenna for WLAN Applications

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Abstract— Modern wireless communication system require low profile, lightweight, and high gain and simple structure antenna to assure reliability, mobility, and high efficiency. Microstrip patch antenna is very simple in construction using a conventional fabrication technique. Microstrip antennas consist of a patch of metallization on a grounded dielectric substrate. A microstrip antenna or patch antenna is a low profile antenna that has a number of advantages over other antennas it is lightweight, low cost, and easy to integrate with accompanying electronics. While the antenna can be 3D in structure (wrapped around an object, for example), the elements are usually flat; hence their other name, planner antennas. Note that a planar antenna is not always a patch antenna. In this review paper, we have studied about various fields of microstrip antenna like antenna bandwidth, gain, frequency and various parameters of antenna etc.

Keywords: Antenna bandwidth, Frequency, Gain, Microstrip antenna, Radiation pattern.

I. INTRODUCTION

Microstrip antennas (often called patch antennas) are widely used in the microwave frequency region because of their simplicity and compatibility with printed-circuit technology, making them easy to manufacture either as stand-alone elements or as elements of arrays. In its simplest form a microstrip antenna consists of a patch of metal, usually rectangular or circular (though other shapes are sometimes used) on top of a grounded substrate [1]. Conventional microstrip antennas in general have a conducting patch printed on a grounded microwave substrate, and have the attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts [1]. However, microstrip antennas inherently have a narrow bandwidth, and bandwidth enhancement is usually demanded for practical applications. In addition, applications in present-day mobile communication systems usually require smaller antenna size in order to meet the miniaturization requirements of mobile units. Thus, size reduction and bandwidth enhancement are becoming major design considerations for practical applications of microstrip antennas. For this reason, studies to achieve compact and broadband operations of microstrip antennas have greatly increased. Much significant progress in the design of compact microstrip antennas with broadband, dual-frequency, dual- polarized, circularly polarized, and gain-enhanced operations have been reported over the past several years [2].

Microstrip antennas are used in a wide range of applications because of their advantageous features in terms of low profile, low cost, light weight and easy fabrication. However two major disadvantages is narrow bandwidth when high dielectric constant material is used for fabrication of the microstrip antenna. Several approaches have been used to enhance the by perturbing the higher order mode by interpolating surface modification into patch geometry. BW enhancement achieved by cutting symmetrical slot on rectangular patch used in simulation at 2GHz which is the key frequency in modern wireless communication era. Microstrip antennas are suitable for modern broad band applications because of their desirable characteristics [3]. Although microstrip antennas in their basic form exhibit limited bandwidth, it has been shown by several re-searchers that the bandwidth can be significantly improved by altering the basic geometry and/or feed or by using impedance matching techniques. However most of the segeometries employ stacked multiple metal/dielectric layers [6], or use modified probe shape (L-, T-, or meander-shaped probes) [7], which elude the primary advantages of microstrip antennas such as ease of fabrication and assembling [10].

II. FOUNDATIONS FOR MICROSTRIP DESIGN

A microstrip patch antenna is a radiating patch on one side of a dielectric substrate, which has a ground plane on the underside [11, pg-2]. The EM waves fringe off the top patch into the substrate, reflecting off the ground plane and radiates out into the air. Radiation occurs mostly due to the fringing field between the patch and ground. The radiation efficiency of the patch antenna depends largely on the permittivity (ε_r) of the dielectric. Ideally, a thick dielectric, low ε_r and low insertion loss is preferred for broadband purposes and increased efficiency. The advantages of microstrip antennas are that they are low-cost, conformable, lightweight and low profile, while both linear and circular polarization is easily achieved. These attributes are desirable when considering antennas for WLAN systems. Some disadvantages include such as a narrow bandwidth as well as a low gain (~6 dB) and polarization purity is hard to achieve [12, pg-3].

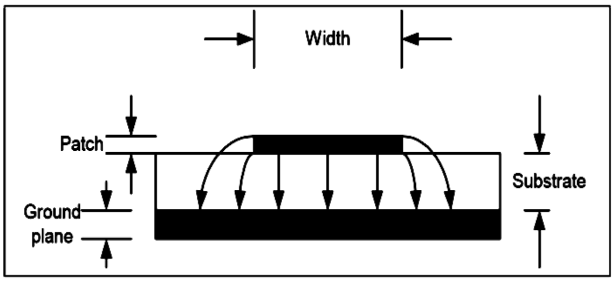

Fig 1: Operations of a Microstrip Patch

A. POLARIZATION TYPES

This is the polarization of the wave radiated by the antenna in that particular direction. This is usually dependant on the feeding technique. When the direction is not specified, it is in the direction of maximum radiation [1]. Shown below are two most widely used polarization types.

a. Linear Polarization

A slot antenna is the counterpart and the simplest form of a linearly polarized antenna. On a slot antenna the E field is orientated perpendicular to its length dimension [13, pg-123]. The usual microstrip patches are just different variations of the slot antenna and all radiate due to linear polarization. Fig-2 illustrates the operations of a linearly polarized wave radiating perpendicular to the patch plane.

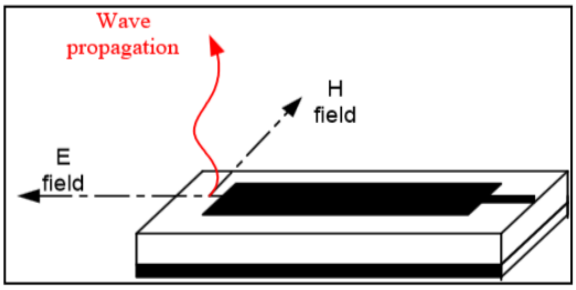

Fig 2: Linear Polarization

b. Circular Polarization

Circular polarization (CP) is usually a result of orthogonally fed signal input. When two signals of equal amplitude but 90^{o} phase shifted the resulting wave is circularly polarized. Circular polarization can result in Left hand circularly polarized (LHCP) where the wave is rotating anticlockwise, or Right hand circularly polarized (RHCP) which denotes a clockwise rotation. The main advantage of using CP is that regardless of receiver orientation, it will always receive a component of the signal. This is due to the resulting wave having an angular variation.

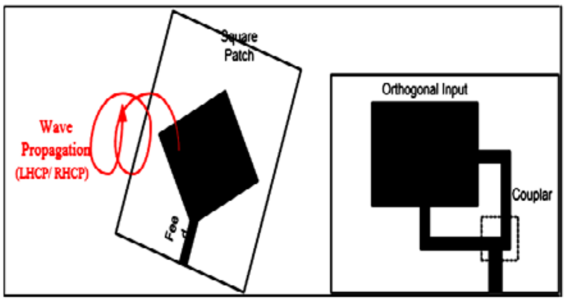

Fig 3: Circular Polarization

B. BANDWIDTH

The bandwidth of the patch is defined as the frequency range over which it is matched with that of the feed line within specified limits. In other words, the frequency range over which the antenna will perform satisfactorily. This means the channels have larger usable frequency range and thus results in increased transmission. The bandwidth of an antenna is usually defined by the acceptable standing wave ratio (SWR) value over the concerned frequency range. The fig 4 shows a typical broadband phenomenon in terms of frequency band usage.

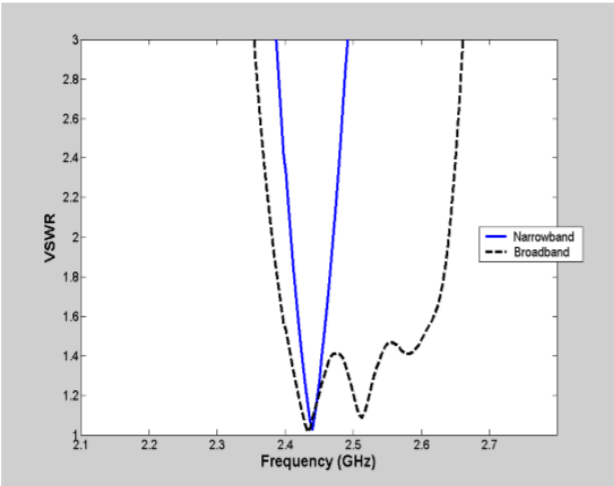

Fig 4: Narrowband vs. Broadband

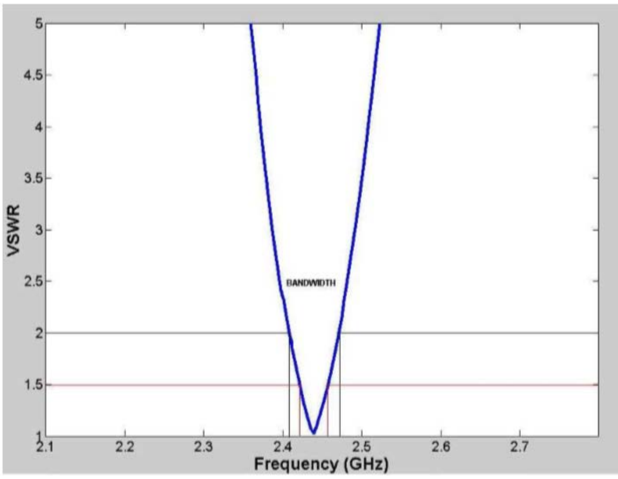

Fig 5: Bandwidth Measurement

Most commercial antennas use a 1.5:1 ratio, as shown in fig 5, suggesting that the range that is covered between the SWR of 1 up to 1.5 is the bandwidth. To ensure comparability with the commercial products, a decision was made to use a 1.5:1 ratio to calculate the bandwidth of antennas.

III. LITERATURE REVIEW

Modern wireless communication system require low profile, lightweight, and high gain and simple structure antenna to assure reliability, mobility, and high efficiency. Microstrip patch antenna is very simple in construction using a conventional fabrication technique. Microstrip antennas consist of a patch of metallization on a grounded dielectric substrate. A microstrip antenna or patch antenna is a low profile antenna that has a number of advantages over other antennas it is lightweight, low cost, and easy to integrate with accompanying electronics. In this paper, we have studied about various parameter of microstrip antenna like antenna array, radiation pattern, frequency and antenna aperture etc. Microstrip antennas (often called patch antennas) are widely used in the microwave frequency region because of their simplicity and compatibility with printed-circuit technology, making them easy to manufacture either as stand-alone elements or as elements of arrays.

The requirements for antennas applied in radar systems vary according to specific application usage. Usually, a radar antenna should be small in size, easily fabricated, and have low profile, light weight, or high gain. These requirements can be satisfied by a microstrip patch antenna array fed by a conventional microstrip feeding network. However, a microstrip-based feeding network usually has higher transmission losses especially at mm-wave frequencies and produces undesirable radiation that can significantly deform the radiation pattern of an antenna system Radiation efficiency depends largely on the substrate permittivity and thickness. Summary of literature review shown in table1.

Table 1: Summary of Literature Review

S No	*Field*	*Author*	*Title*	*Approach*	*Result*
1	Antenna Bandwidth	Dipshikha Goswami Anjali Chaudhari [14]	High Bandwidth Microstrip Antenna Using Electromagnetic Band Gap Structures for Cellular System and Satellite Communication	A spoon type microstrip patch is proposed with slots and EBG structures. The antenna with spoon type patch and two slots without EBG gives the bandwidth of 8.64 GHz (2.22-10.86 GHz), whereas with EBG and two slots gives the bandwidth of 15.71 GHz (2.27 – 17.98 GHz).	The maximum bandwidth covered by this antenna is 8.64 GHz and the impedance bandwidth is 132.11%.
		Zhijun Zhang”, Magdy F. Iskander’, Jean Christophe Lange, Jim Mathews’[15]	Wideband Dipole Antenna for WLAN	A novel dualband dipole antenna for wireless local area network (WLAN) is proposed in this paper. A prototype dipole was made and measured. Measured VSWR 2:l bandwidth is 710MHz at 2.4GHz band and wider than IGHz at 5GHz band. Measured 3:l bandwidth is wider than 3.6GHz. ranging from 2.32GHz to above 6GHz.	The dipole achieves 85%-87% efficiency in the 2.4GH.z band and 55-64% efficiency in the 5GHz band.
		Nishu Goyal, Sukhwinder Singh Dhillon and Anupma Marwaha[16]	Hybrid Fractal Microstrip Patch Antenna for Wireless Applications	A dual band hybrid fractal antenna is presented in this paper. The proposed antenna resonates at 4GHz and 7GHz with frequency bandwidth of 1.05GHz and 570MHz respectively. This hybrid structure is the combination of Koch and Minkowski curve and can be used for satellite communication,	As per the different number of iterations the performance results of Koch and Minkowski curve are compared with the proposed structure, which shows that the proposed design will operate well at both the frequencies (4GHz and 7GHz) of resonance as

				WiFi, RADAR systems and radio telecommunication.	dual model for C band applications.
		Young-Ho Suh and Kai Chang [17]	Low cost microstrip-fed dual frequency printed dipole antenna for wireless communications	A LOW cost microstrip-fed dual frequency dipole antenna has been developed for personal communication network (PCN) and wireless LAN (WLAN) applications in the 2.4 and 5.2 GHZ.	The l0dB bandwidths achieved were 18.75 and 7.11% at 2.4 and 5.2 GHZ respectively

S No	***Field***	***Author***	***Title***	***Approach***	***Result***
2	Antenna Gain	P. RaviKumar D. Arun Kumar P.Devipradeep[18]	Gain and Bandwidth Enhancement of a Circular Microstrip Patch Antenna Using an Air Layer between Two Substrates	This paper describes the gain and bandwidth improvement of a circular microstrip patch antenna using two substrates separated by an air layer between them. The microstrip patch antenna was fed by line and included an air layer between two substrates.	The gain of this antenna was 2.4 db greater than that of a conventional circular patch antenna. The bandwidth of this antenna was 1.33% greater than that of a conventional circular patch antenna.
		Qihong Zhong, Yuanxin Li, Hongyan Jiang, Yunliang Long [19]	Design of a Novel Dual-frequency Microstrip Patch Antenna for WLAN Applications	A novel dual-frequency microstrip patch antenna for WLAN applications is presented and demonstrated. By embedding two pairs of arc shaped slots with a narrow slot protruding at each side, dual-band operation with its operating mode centered at about frequency 2.4GHz and 5.2GHz has been obtained.	The proposed antenna has good gain and its impedance bandwidths defined by VSWR=2 can meet the requirements of dual ISM bands.
		Fitri Yuli Zulkifli, Rakhmatyar Ridha, Basari dan Eko Tjipto Rahardjo [20]	Compact Folded Dipole Microstrip Antenna for 2.4 GHz WLAN Application	A compact folded dipole microstrip antenna for 2.4 GHz application is presented and investigated in this paper. The design is conducted on FR4 substrate with 0.3 mm thickness and dielectric constant $\varepsilon r = 4.5$.	The measurement result shows that the frequency resonant of the antenna is at 2.46 GHz with return loss -24.10 dB, bandwidth 193 MHz and gain 1.52 dB.

S No	***Field***	***Author***	***Title***	***Approach***	***Result***
3	Antenna Frequency	James R. Kelly Alejandro Borja [21]	Reconfigurable Microwave Circuit Based on Three Triangular Microstrip Patches	This paper presents an early step toward the development of this technology. Specifically the paper describes a device which comprises three triangular microstrip patches. This circuit can operate as a 3-pole bandpass filter or a narrowband antenna. Different functionality is available on different ports of the device and there is no requirement for any microwave switches.	In comparison with a device incorporating switches this would reduce losses and simplify the structure.

S No	Field	Author	Title	Approach	Result
4	Antenna Polarization	Manoj S Parihar, Student, A.Basu, Member, and S. K. Koul, [22]	Polarization Reconfigurable Microstrip Antenna	Microstrip patch antenna with circular corner truncation is proposed to achieve polarization reconfigurability. By applying forward bias, reverse bias or zero bias to the four PIN diodes, the antenna can radiate with Right Hand Circular Polarization (RHCP), Left Hand Circular Polarization (LHCP) and Linear Polarization (LP).	Simulations as well as experimental results show that proposed antenna demonstrates a very good impedance match for all the three different polarizations without any additional matching network.

IV. CONCLUSION

In this review paper, we studied in the previous work which was discuss in literature review shows that there is need to improvement in various parameters of microstrip antenna. The recent advancement has done improvement of antenna aperture, antenna array, Gain, Bandwidth etc. The microstrip antenna having applications in RF/Microwave devices. So the major areas of research in the microstrip antennas are the bandwidth, gain, directivity of the antenna. In brief the problems are:

- *Enhanced bandwidth of antenna*
- *Proper operation in desired frequency band with additional support*
- *Minimum return loss which enhances the antenna efficiency in operating band*
- *Minimum insertion loss so that the maximum utilization of received signal*
- *Compact hardware size so that supports in wide range of practical applications*

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