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A Review on Microstrip Patch Antenna for Wireless Communication

Ashok Kumar Pandey, Dr. Saiyed Salim Saiyed
Department of Electronics and Communication Engineering,
Budhha Institute of Technology, GIDA
Gorakhpur-273009, U.P., India.

Abstract: This paper describes a study on latest researches of Microstrip Patch antenna in the field of wireless communication. The antennas used in various electronics devices have restriction of small size with broader bandwidth for multiple of applications. The main applications of MPA are GPS, WLAN, Bluetooth™, 5G and 6G, Later medium high frequency digital radio, Band II analog FM, DAB (Digital Audio Broadcasting), and DRM (Digital Radio Mondial).

Index Term: MPA, characteristics, applications, mobile phone antenna.

I. INTRODUCTION

In this paper we study a microstrip patch antenna, that operates on the principle of radiating and receiving electromagnetic waves. It consists of a metallic patch printed on a dielectric substrate, usually a low-loss and high-permittivity material, such as fiberglass or ceramic. This type of antenna is widely used in wireless communication systems due to its compact size, lightweight construction, low profile, and compatibility with integrated circuits. Antennas for 2.45 GHz are used in various wireless communication systems, including TV broadcasts, microwave ovens, mobile phones, WLAN, Bluetooth, GPS, and two-way radios [1]

The microstrip patch antenna works based on the concept of the dielectric resonator. The patch acts as a resonator, which means it stores electromagnetic energy and oscillates at specific frequencies. When a high-frequency signal is applied to the patch, it resonates at a particular frequency determined by its dimensions and surrounding environment. The patch antenna radiates electromagnetic waves through the aperture in the ground plane, created by removing the metal underneath the patch. The size and shape of the patch determine the characteristics of the radiated waves, such as the radiation pattern, gain, and polarization. By carefully designing the patch dimensions and the ground plane, the antenna's performance can be optimized for specific wireless communication requirements.

Microstrip patch antennas have gained widespread popularity in wireless communication systems due to several advantages they offer as compact size, low profile, low cost, light weight, design flexibility.
The applications of microstrip patch antennas in areas such as satellite communication, wireless local area networks (WLANs), radio frequency identification (RFID) systems, mobile communication, and radar systems. It highlights the unique requirements and challenges associated with each application domain. [3].

II. GAIN IMPROVEMENT TECHNIQUES OF MPA

The investigation shows, a coaxial feed was applied for MPA with Fr-4 epoxy substrate having a dielectric constant of 4.4.

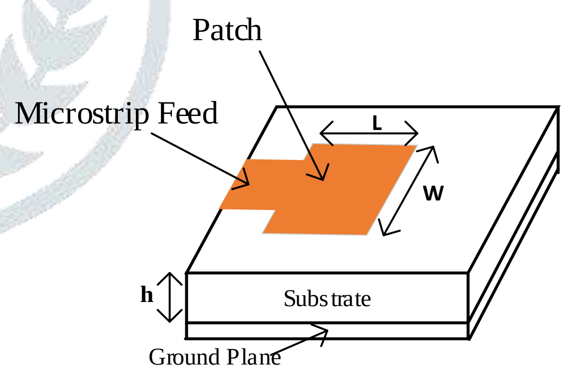

fig.1: Microstrip Patch Antenna

This antenna is depicted. The substrate used in the design is 1.6mm thick. Coaxial feed or probe feed is one of the most common methods for feeding microstrip patch antennas, in comparison to the inset feed technique. In this feeding method, the inner conductor of the coaxial connector extends through 2404952_537777_403_406conductor is linked to the ground plane. The key benefit of this type of feeding method is that it allows for flexible placement of the feed within the patch to achieve impedance matching of 50Ω. The initial coaxial probe feed Microstrip patch has resulted in a gain of 4.798 dB (PDF) Gain Enhanced 2.4 GHz Slotted Rectangular Microstrip Patch Antenna with FR-4 Epoxy substrate [3].

III. EFFECT OF PARAMETER VARIATION

TABLE I

Effect of Parameter variation	
Parameters	**Effect**
Width	To control impedance matching.
Height	To control bandwidth
Length	To increase inductance of the antenna and determine resonance frequency
Width of shorting plate	Affect on the anti resonance and increase bandwidth.
Width between shorting plate and feeding position	Affect on resonance frequency and bandwidth

IV. CHARACTERISTIC ANALYSIS

Directivity: The directivity for PIFA at 2.45 GHz, 3.35GHz and 5.25GHz was reported as 5.11dB, 4.39 dB and 3.94 dB [2]. The radiation pattern also shows that it is omni-directional. Therefore, it fulfills the requirement of mobile phone antenna.

Return Loss: The return loss for PIFA should be less than -10dB, presently it is minimized to -60 dB [4]. Whereas the practical design specification for return loss is -6 dB [2].

Bandwidth: Bandwidth determine by -10dB return loss found to be 1150 MHz to covers the DCS1800 (1710–1880 MHz), DCS1900 (1850–1990 MHz), IMT2000 (1885–2200 MHz), WLAN (2400–2483 MHz), and DMB (2605–2655 MHz) [3]. The bandwidth required for mobile phone is at least 500 MHz by FCC.

Diversity: The effective diversity is obtained in terms of diversity gain. Diversity gain is calculated using

$$DG = 10\sqrt{1 - |ECC|^2}$$

Where ECC is Envelope Correlation Coefficient. The reported diversity gain is more than 8 dB [4].

VSWR: The reported VSWR bandwidth for UWB is 1.66:1 where min VSWR is 1.66 and max VSWR is 1.93[5]. VSWR should be less than 2.

SAR: The specific absorption ratio, is the measurement of penetration of electromagnetic waves into human tissues found to be 1.33mW/g for 1g at 2GHz and 1.06mW/g for 1g at 1.8GHz, which follow the standard criteria (SAR < 1.6mW/g for 1g) [6].

Radiation Efficiency: Radiation efficiency of a dual mode dual band antenna having operating frequency of 1.9 GHz and 2.45 GHz achieves 50 % more radiation [7].

V. APPLICATION OF PIFA

Microstrip patch antenna (MPA) offers several other benefits as well. These two methods are often seen as low-cost, adaptable, dependable, high-speed data connection choices that promote user mobility. Due to lower latency, greater transmission speed, wider bandwidth, and the possibility to connect with greater multiple devices, fifth-generation (5G) networks are far better than 4G.

VI. COMPARATIVE STUDY OF MICROSTRIP PATCH ANTENNAS

As we observe that the various MPA is uses in different shape, dimension and dielectric material etc. by many applications. There is some modification evolve in MPA to achieve the better gain and good bandwidth value.

TABLE III

S. No.	Review papers	Outcomes
1.	"A review of 2.45 GHz microstrip patch antennas for wireless applications"	Antennas designed for 2.45 GHz are used in various wireless communication systems, including TV broadcasts, microwave ovens, mobile phones, WLAN, Bluetooth, GPS, and two-way radios
2.	"Design and Improvement of Microstrip Patch Antenna Parameters Using Deflected Ground Structure"	The Proposed microstrip patch antenna (PMPA) shows better performance with impedance resistance and reactance of 43Ω and 50Ω, return loss of 3.1dB, VSWR of 3.1dB
3.	"Gain Enhanced 2.4 GHz Slotted Rectangular Microstrip Patch Antenna with FR-4 Epoxy Substrate."	a perfect voltage standing wave ratio (VSWR) of 1.188, and a good fractional bandwidth of 90 MHz with-24.5996 dB of S11, which makes it function well in IoT applications
4.	"Design of Patch Microstrip Antenna with improved characteristics and its performance at 5.1GHz for Wireless Applications."	This rectangular microstrip patch antenna is designed for wireless communication application that works at 2.4 GHz with gain 11 d B for outdoor place. It also has a wide angle of beam in its radiation

		pattern
5.	"Performance analysis of microstrip patch antenna for wireless communication systems"	Microstrip patch antenna (MPA) offers several other benefits as well. These two methods are often seen as low-cost, adaptable, dependable, high-speed data connection choices that promote user mobility
6.	"MATLAB based microstrip patch antenna design and simulation for s-band wireless communications"	The MPA uses a flare retardant substance as a substrate. An RL of-38.86 decibels at a frequency of 2.3933 GHz, the MPA was found to be capable of operating with a BW of 57 MHz and a VSWR of 1.002. The antenna's volume is 75.805 x 57.223 x 1.6.
7.	"Design and analysis of microstrip patch antenna for 5G wireless communication systems"	Due to lower latency, greater transmission speed, wider bandwidth, and the possibility to connect with greater multiple devices, fifth-generation (5G) networks are far better than 4G. In this study, a microstrip patch antenna operating at 28 GHz is investigated and modeled for future 5G communication technologies.

An Epoxy material FR-4 was employed as the substrate; a dielectric constant of 4.4 and a thickness of 1.6 mm. The ground and patch elements were made out of copper with a thickness of 0.06 mm. The antenna has a gain of up to 5.34 dB, [3].

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VII. CONCLUSION

In present era as the multiple of applications are uses in wireless communication, so the research work specifically focuses to providing multiple bands with good radiation pattern to the MPA. It has excellent gain and bandwidth value and available in various dimensions so we flexibly positioned the antenna in the devices. The lower cost of MPA drawing the attention of users. One of the attractive features of MPA is, to comprise all the requirements within miniature space of electronic devices. As we don't have much space in electronic devices for multiple antennas so we use an antenna of multiple bands to cover all the applications hence multiband MPA is the prime requirement of present generation

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