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A Review Paper on Multiband Microstrip Patch Antenna

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Abstract - *In this paper, we review multiband microstrip patch antennas based on many different design techniques & operating principles along with its properties & configurations. Multiband antennas have become attractive due to their inherent feature of being a single solution to many requirements associated with different frequency bands. This paper presents a comparative study of different multiband antennas, their operating principles, associated parameters & applications in terms of frequency bands.*

Key Words: Multiband, Microstrip patch, Strip, X-band, concentric ring.

1. INTRODUCTION

Microstrip patch antennas are very useful as planar antenna structure having advantages such as low profile, low manufacturing cost, low power requirements etc. A patch antenna hence now is required to be used in different fields of science & technology for various applications. Many antenna applications cover different frequency bands of the spectrum & there is a need to design an antenna which can perform adequately for many frequency bands without changing the configuration or structure of the antenna [1].

There have been a lot of research so far in the field of Multiband patch antenna design. Inherent disadvantages of a patch antenna such as low gain, low bandwidth, low efficiency etc. are being worked up on. Researches have proposed many techniques to provide high gain, high bandwidth & efficiency for a particular band or type of a patch antenna. Some structures are being specific to special bands & applications limit their scope. Maintaining the basic advantages of a Microstrip patch antenna & at the same time eliminating its drawbacks is a tricky task to perform for antenna researchers [1].

A Multiband microstrip patch antenna is an antenna which works adequately on several frequency bands, hence become suitable for multiple applications such as Wi-Fi, Bluetooth, Satellite communication, RADAR applications, ISM band applications for household devices & scientific & industrial systems. Such a wide range of applications of wireless communication require an antenna which is not only carrying low losses & high efficiency but also can perform effectively for different bands of microwave frequency, known as a multiband antenna [2].

2. DIFFERENT APPROACHES & CONFIGURATIONS

Many designs & techniques have been studied & proposed in literature to achieve multiband property of a patch antenna with high gain, high bandwidth & high efficiency.

As in [3], a multiband double layered microstrip patch antenna is presented, consisting of two tri-slot elements, which are fed by a proximity coupling from a certain feeding structure located on another layer. The antenna works at four frequency bands, which is achieved through forming the antenna patch by three slots. Whereas low gain of approx. 1.13dBi makes it less applicable in practical use. In [4], a single microstrip G-shape antenna for multiband operations is proposed first & in order to increase its gain; an identical dual-element patch antenna is also proposed for the same band. The array elements are fed by only one feed network, which improves the impedance bandwidth of the two element G-shape microstrip antenna.

In [5], a frequency tunable dual-band Multi ring microstrip antenna fed by an L-probe with varactor diodes is proposed. In order to tune operating frequencies of the multi-ring microstrip antenna, two varactor diodes are mounted on each ring patch. An L-probe placed under the ring patches is used to feed them. In [6], a new microstrip monopole antenna with triple band coverage capability is proposed. To achieve multiband characteristics, ground plane & feed line has been modified. Finally, inserting PIN diodes on the ground plane of the antenna has led to three different desirable switchable bands of operation.

In [7], a multiband MPA incorporating inverted L & T-shaped parasitic elements is proposed to cover 3 bands. A further refinement of the multiband microstrip antenna concept involves adding a stub, which increases the antenna size, and a slot, which produces the radiation pattern of the harmonics. Multiple bands covered are Long Term Evolution time-division duplexing number 34 (LTE TDD No. 34: 2.0175 GHz), wireless local area network (WLAN: 2.45 GHz), and Worldwide Interoperability for Microwave Access (WiMAX: 3.5 GHz) bands.

Inverted L & T-shaped parasitic elements that resonate through perturbation & coupling with the MPA are used in this design.

In [8], DGS (Defective Ground Structure), which is composed of four arms spirals is introduced & produces 5 resonant frequencies. Microstrip patch antennas, however, suffer from

a number of disadvantages as the patch length is around half wavelength and the antenna resonates at a fundamental TM_{010} frequency. DGS method is also used for size reduction as well as multi-band operations. Inset feed is used as feeding technique for this antenna design. Maximum gain achieved is 4.5dBi.

In [9], design of multiband microstrip antenna for ISM band applications is proposed. It utilizes a three-arm radiating element with various arms lengths to create three different resonances. The maximum gain achieved is 4.91dBi. In [10], a compact multiband planar monopole microstrip antenna for modern mobile phone applications, is presented. Here, a combination of slots & strips, in the radiating patch & the ground plane, has been employed to achieve good radiation & multiband performance of the antenna.

In [11], multiband antenna array using 2*2 elements with multilayer structure & excited with probe feeding is being proposed. To improve the gain, the array structure is being proposed in this paper, & to achieve multiband operation, double U-slot is cut on every patch element. Maximum gain is 9.84dBi. In [12], an approach to implement an array of split ring resonators (SRR) as a part of antenna structure is presented for exciting multiband property of a single band microstrip patch antenna. It has been shown that the array of SRR & thin wires has contributed to produce the second & third resonant frequencies of proposed multiband printed antenna in the range of 1-3 GHz, while the first resonant frequency was generated by the square patch.

3. PERFORMANCE COMPARISON & APPLICATIONS OF MULTIBAND MICROSTRIP ANTENNA

Ref.	No. of Bands & Resonant freq. (f_r) in GHz	Peak Gain (dBi)	Max. Bandwidth (MHz)	Appli-cations
[3]	4, S- band (3.1 GHz), C-band (5.8 GZz & 7.4 GHz), X-band (9.8 GHz)	1.1	≥ 500	WiMAX, Wi-Fi
[4]	3, S-band (3.7GHz), C-band (5.2GHz & 5.8 GHz)	5	100	WiMAX, Wi-Fi
[5]	2, S- band (3.6 GHz) & C-band (5 GHz)	1	500	WiMAX, Wi-Fi
[6]	3, S-band (2.3 GHz & 3.4 GHz) & C-band (5 GHz)	1.6	150	Bluetooth, WiMAX, WLAN
[7]	3, S-band (2.0175 GHz, 2.45 GHz & 3.5 GHz)	3.6	255	LTE, WLAN, WiMAX
[8]	3, S-band (2.5 GHz & 3.8 GHz) C-band (5.25 GHz)	4.5	50	Bluetooth, Wi-Fi
[9]	3, L-band (0.9 GHz), S-band (2.4 GHz), C-band (5.2 GHz)	4.9	307	ISM Band, WLAN, Bluetooth
[10]	5, L-band (0.824 GHz & 1.85 GHz), S-band (2.4 GHz & 2.5 GHz), C-band (5.1 GHz)	5.9	600	GSM, WLAN, WiMAX
[11]	6, L-band (1.64 GHz, 1.74 GHz & 1.9 GHz), S- band (2.3 GHz, 2.6 GHz & 2.9 GHz)	9.8	80	WiMAX, Bluetooth, Wi-Fi
[12]	3, L-band (1.4 GHz), S- band (2.4 GHz & 2.8 GHz)	2	330	GPS, WLAN

4. CONCLUDING REMARK

Number of bands can be increased using the concept of strips & slots, equating circuit model of inductors & capacitors respectively. Further improvement in gain & bands is achievable by using Metamaterials, Split ring resonators, Dielectric resonators etc. Multiband Microstrip Patch Antennae are efficient enough for applications such as RADAR communication, satellite communication, air traffic control, speed detection of road vehicles.

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