Review Paper For Compact Shaped UWB Antenna

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***Abstract*-** *consideration of Ultra-Wide Band (UWB) Microstrip antenna using some loaded rectangular slot in patch and DGS. An analytical study of the effects of different size and shapes of slots on the performance characteristic of UWB Microstrip antenna is presented. Insertion of slot and the changes in dimension of ground plane has a high impact on the behavior and parameter of the patch antenna. To improve the bandwidth of the patch antenna, proper insertion of slot on the planer patch structure has been used. In the paper, we will design a rectangular patch antenna carved on FR4 substrate. Simulated result will show the operation of the antenna in the entire UWB range. This parametric study would be of a great interest in the designing of compact antennas for wireless communications operating in UWB*

Keywords- Ultra-wide band, Rectangular microstrip patch antenna, S-Parameters, smith chart, radiation pattern, bandwidth, VSWR, resonant frequency, HFSS.

I. INTRODUCTION

UWB is one of the most interested wireless communication systems which can be used for monitoring, positioning, security, microwave imaging and various communication application. Due to its high gain, omni-directional radiation pattern, high data resolution, low complexity, inexpensive properties, it is becoming more attractive research phenomena for students and wireless communication. The antennas with ultra wideband frequency have been broadly researched and developed after the declaration of the unlicensed bandwidth of 3.1 to 10.6 GHz as UWB by Federal Communication Commission (FCC) [1]. Printed slot type antennas are mostly accepted for UWB application. It is still a challenge to antenna designers to design a compact, cost effective, high gain ultra wideband antennas. In recent years, due to its various number of benefits including stable radiation pattern, high gain, low profile and inexpensive fabrication the printed microstrip slot antennas were significantly researched. For UWB applications numerous antennas were designed. Among them, one of the antenna requires a large ground plane that rises dimension. As a result, that is not included in microwave integration [2]. Various line feeding and waveguide feeding antennas were offered for UWB applications. For achieving the characteristics of wide impedance bandwidth monopole architectures are commonly used, such as elliptical, pentagon, rectangular, square, hexagonal, annular ring and circular ring antennas [3-7].

The present wireless communication design of an antenna with dual-band, triple band, and multiband or ultra-wide band (UWB) operation has become more popular. These antennas reducing the size of the communication system and reduce the interference. The planar patch antenna recently has become popular due to its low Q -factor with the function of dual-band or multiband operation to provide easy creation of multiple resonating paths. The well-known technique for effectively increase operating bands is by adding shaped slots like the annular ring to the designed patch [1-3]. A low-profile compact dual-band antenna for WLAN/WAVE applications has been reported in with coplanar waveguide (CPW) feed. In [5] dual-band patch antenna with spiral shaped electromagnetic band gap (EBG) structures has been discussed. It is shown in [6] that microstrip line fed printed wide-slot antenna with a parasitic center patch which is resonating at dual frequencies. The design of reduced size patch antennas loaded with CSRR produces dual-band with the dual polarization which has been discussed. In its most basic form, a microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate, which has a ground plane on the other side as shown in Figure 1.

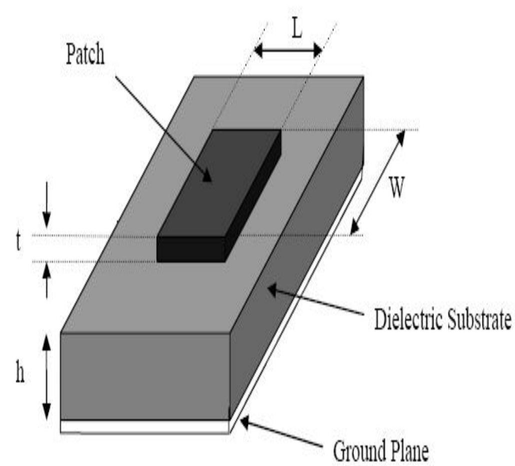

Figure 1:- Structure of a microstrip patch antenna[1].

The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate.

In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shapes. Rectangular patches are probably the most utilized patch geometry. It has the largest impedance bandwidth compared to other types of geometries, and is the main research interest in this project. Circular and elliptical shapes are slightly smaller than of rectangular patches. Thus it will have smaller bandwidth and gain. This circular geometry patches were difficult to analyze due to its inherent geometry.

II. LITERATURE SURVEY

Abdel Fattah Sheta *et al.* [2011] He design of proposed antenna is depicted.. The antenna proposed here is using Multi-patch multi-frequency antenna method. For multi-stacked multi-patch antenna method all substrate that contain different radiation patch are stacked. While for the co-planar multi patch antenna method each radiation patch that resonate at different frequency are arranged in one layer substrate. To achieve triple band characteristic, for each band, a rectangular patch is designed base on the well known rectangular resonant frequency formula. Each patch is combined into one single antenna separated by slots with U shape. Therefore the 2.3 GHz, 3.3 GHz band and the 5 GHz band are combined by U slots. Characteristic at 5 GHz band, two slots are embedded in opposite position which forms the shape[11].

P.Mythili *et al.* [2012], A novel compact multiband microstrip antenna was designed and tested. The antenna dimensions were 33 x 33mm2 inclusive of the patch and the GP. This antenna with its bands from 1.7 to 2.5 and 4.5 to 5.35 GHz covered the GSM, GPS, DCS, PCS, UMTS, IEEE 802.11 b/g and WLAN IEEE802.11a band (5.15-5.35 GHz)[13].

Muhammad R. Khan *et al.* [2013] this presents a compact multiband planar monopole microstrip antenna for modern mobile phone applications. The proposed antenna covers the following wireless communication bands: GSM, PCS, UMTS, WLAN and Wi-MAX frequency bands. A new technique of using a combination of slots and slits in the radiation patch and the ground plane has been employed to achieve the multiband performance of the antenna. The proposed antenna exhibits good radiation performance in terms of gain, return loss, and compactness. The proposed antenna is suitable for many wireless handheld devices. A good agreement between the simulated and the experimental results is achieved. The antenna has good radiation performance with acceptable gain over the targeted frequency bands. The antenna is compact and planar that makes it suitable and attractive for slim handheld devices

Zuhura Juma Ali *et al.* [2014] This paper presents a miniaturized planar circular disc UWB antenna design for wireless communications. Printed on a dielectric substrate and fed by 50Ω microstrip line with truncated ground plane, the proposed antenna has been demonstrated to provide an ultra wide 10dB return loss bandwidth with satisfactory radiation properties. The special structure reduces the spatial volume and it is used to realize the miniaturization of the antenna. Ansoft High Frequency structure Simulator (HFSS) software tool has been employed for obtaining the simulation results. The return loss, voltage standing wave ratio (VSWR), radiation patterns and current distributions of the antenna are discussed.[17]

Alejandro Borja *et al.* [2015] The ultimate aim of the research, presented in this paper, is to create a block of hardware which can be reconfigured to assume any given circuit function (e.g. filter, coupler, antenna, etc). Ultimately the hardware should be capable of performing those functions over any given bandwidth and at any required frequency. In essence what we have described is the microwave equivalent of a Field Programmable Gate Array (FPGA). This paper presents an early step toward the development of this technology. Specifically the paper describes a 3 port device, based around a single resonant element; namely a triangular microstrip patch. The device incorporates 7 microwave switches. These switches enable the device to be reconfigured between two different modes, namely narrowband antenna and 2-pole bandpass filter. Filter mode performance is obtained between ports 1 and 2. Antenna mode performance is obtained on port 3[21].

Chandra Bhan *et al.* [2015] The microstrip U-shape slotted patch antennas have been drawing attention in various wireless interoperability microwave access (WiMAX) applications since last two decade. The U-shape slotted microstrip antennas have grown as a dominant part of research with their vital roles in mobiles and satellite communication. In this paper design of U shape slotted microstrip antenna is proposed which work at four bands with appreciable gains. It can be used in S-band, C-band and X band communication systems. The substrate Teflon based material of permittivity 2.08 is selected for U-shape microstrip patch antenna design. Proposal to measure different bandwidths has been exercised for the HFSS 13.0 (High Frequency Structure Simulator) based model[22].

R. K.Sharan *et al.* [2016] This paper proposed an edge tapered wideband rectangular patch antenna with one slot at the center and parasitic stubs on two sides of the patch. In this paper partial ground is used. The height of the ground is varied from 8.6mm to 9.2mm and their effect on return loss was measured. Also the effect of varying the length of parasitic stub was measured. Length was varied from 4 to 8 mm. This antenna was designed for wideband applications having bandwidth of 112%. The overall dimension of the antenna is 35 × 35 × 1.6 mm3 [23].

M. Tarikul Islam *et al.* [2016] In this paper, a new compact spectacles shaped patch UWB antenna using a microstrip fed line is proposed. The new design is consist of a spectacles shaped patch along with tapered slot ground plane. The proposed antenna has a compact electrical dimension of 0.24 λ × 0.21 λ × 0.016 λ and fed with a 50- ohm microstrip transmission line. Computer Simulation Technology (CST) based on finite-difference time-domain method and High Frequency Structural Simulator (HFSS) based on finite element method is implemented in this research. In simulation, a wider frequency bandwidth of 8.5 GHz (3.0 - 11.5 GHz) with excellent impedance matching which covers entire UWB frequency, stable radiation pattern and constant gain is achieved. The proposed antenna is low profile, inexpensive and has excellent characteristics of UWB[24].

P.Surendra Kumar *et al.* [2016] The scope of this research paper is to present a new configuration of the dual frequency microstrip patch antenna for wireless local area network WLAN (5.15-5.35) GHz and Worldwide Interoperability for Microwave Access WiMAX (3.4-3.9) GHz applications. The proposed dual-frequency rectangular microstrip antenna with the vertex-fed pentagonal slot is resonates at 3.5 GHz and 5.15 GHz. The antenna performance parameters at 3.5 GHz are the magnitude of the reflection coefficient, VSWR, input impedance, gain and radiation efficiency are found to be 19.12 dB, 1.25, 40.15 , 5.6 dBi and 62.42% respectively. While at 5.15 GHz they are found to be 25.28 dB, 1.11, 49.55, 4.55dBi and 63.61% respectively. The proposed antenna achieved an average gain of 5.08 dBi. The stable radiation pattern is observed in both operating frequencies. The performance of proposed antenna is compared with the existing dual-band designs available in the literature[25].

Authors	Year	Technique (Brief Description)	Result	Drawback
Muhammad R. Khan, Mohamed M. Morsy, F. J. Harackiewicz	2011	This presents a compact multiband planar monopole microstrip antenna for modern mobile phone applications. A new technique of using a combination of slots and slits in the radiation patch and the ground plane has been employed to achieve the multiband performance of the antenna.	A multiband antenna is designed	Interference occurred
Zuhura Juma Ali	2014	This paper presents a miniaturized planar circular disc UWB antenna design for wireless communications. The proposed antenna has been demonstrated to provide an ultra wide 10dB return loss bandwidth with satisfactory radiation properties.	A Ultra Wide-band antenna using circular disc on patch is designed	Complexity in designing circular disc
Udit Raithatha, S. Sreenath Kashyap & D. Shivakrishna	2015	This paper represents the design of Swastika shaped microstrip patch antenna for Industrial Scientific and Medical (ISM) band applications. The design has four slots as same as Swastika shape into it.	A four slot multiband antenna is designed	Coaxial feeding is used in which feed point is not completely recognized.
Gurpreet Kaur, Er. Sonia Goyal	2016	An rectangular patch with parasitic stub whose edge have been cut , with two slots near the feed line has been proposed	An edge tapered wideband antenna is designed	High VSWR
Ranjan Mishra, Raj Gaurav Mishra, Piyush Kuchha	2016	An analytical study of the effects of different size and shapes of slots on the performance characteristic of UWB Microstrip antenna is presented. Insertion of slot has a high impact on the behavior and parameter of the patch antenna.	A simple rectangular slot of proper size and at the proper matched distance on the radiating patch will provide a perfect matching and this yields a high Bandwidth.	Low Impedance Matching but VSWR is good

Ranjan Mishra *et al.* [2016] This research paper presents a simple design consideration of Ultra-Wide Band (UWB) Microstrip antenna using a centrally loaded rectangular slot. An analytical study of the effects of different size and shapes of slots on the performance characteristic of UWB Microstrip antenna is presented. Insertion of slot and the changes in dimension of ground plane has a high impact on the behavior and parameter of the patch antenna. To improve the bandwidth of the patch antenna, proper insertion of slot on the planer patch structure has been used. In the paper 12mm by 15.6 mm rectangular patch antenna carved on FR4 substrate is presented. Both the simulated and the measured result show the operation of the antenna in the entire UWB range. This parametric study would be of a great interest in the designing of compact antennas for wireless communications operating in UWB. [Reference Paper] [26].

Jagori Raychaudhuri *et al.* [2016] In this paper, a suspended, compact, circularly polarized microstrip antenna with “SWASTIKA” shaped slot has been introduced which can be operated within the ISM band covering the range of 433 MHz—434.79 MHz. The antenna has been designed using two 1.59 mm FR4 substrate layers with an air gap of 1.59 mm. The antenna has been optimized using method of moment based commercially available electromagnetic simulator. A fair response of less than –10 dB return loss and less than 3 dB axial ratio has been observed for the proposed bandwidth. Based on the optimized configuration, an antenna is fabricated for ground penetrating radar (GPR) application[27].

Amit A. Deshmukh *et al.* [2016] Circular polarized response is realized when two orthogonal closely spaced resonant modes are excited in the patch. An E-shaped patch design using unequal lengths rectangular slots to give circular polarized response was reported. In the reported paper, proper analysis on resonant mode excited in the patch that gives circularly polarization is not explained. An extensive analysis explaining the effects of unequal length slots that gives circularly polarized response is presented in the present paper. The rectangular slots realizes tuning of higher order TM02 mode with respect to fundamental TM10 mode. Further, unequal lengths of two slots and feed point location optimizes the surface current contributions in orthogonal directions inside the patch which yields circularly polarized response. Thus, proposed study gives an insight into the functioning of circular polarized antenna that will help in designing similar configuration at other required frequencies[28].

B. Zoubiri *et al.* [2016] In this paper, the performance of a rectangular microstrip patch antenna fed by a coaxial probe has been enhanced by perforating elliptically periodic holes in both substrate and resonant element. A parametric analysis of the required number of holes and their dimensions are carried out, in order to increase the gain. The proposed antenna was designed and simulated by CST Microwave Studio. Obtained results that concern the return loss and radiation patterns show the significant enhancement of the antenna gain for the same operating frequency[29].

III. METHODOLOGY

The length of the patch is denoted by L and width of the patch is denoted by W. Because the dimensions of the patch are finite along the length and width, the fields at the edges of the patch undergo fringing. Since some of the waves travel in the substrate and some in air, an effective dielectric constant $\varepsilon reff$ is introduced to account for fringing and the wave propagation in the line.

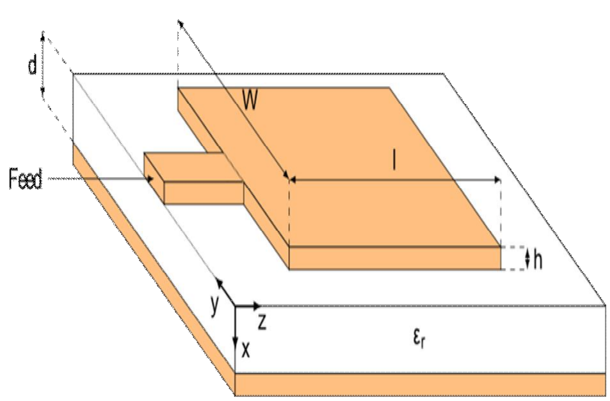

Figure 2 Basic Geometry of Microstrip Patch Antenna[2]

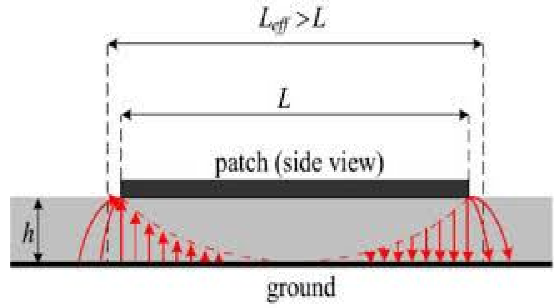

Figure 3. Effect on length due to Fringing[2]

The dimension the patch along its length has been extended by a distance ΔL due to the fringing field which is a function of effective dielectric constant. Hence the effective length is increased by 2ΔL.

Various formulas for designing a microstrip patch antenna are written below.

Calculation of effective dielectric constant, εreff, which is given by:

$$\varepsilon_{reff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Calculation of the length extension Δ*L, which is given by:*

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

For efficient radiation, the width W is

$$W = \frac{\lambda_0}{2\sqrt{(\epsilon_r+1)/2}}$$

Now to calculate the length of patch becomes:

$$L = \frac{\lambda_0}{2\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

Length and width of the ground is:

$$L_g = 6h + L$$

$$W_g = 6h + W$$

IV. IMPROVEMENT AS PER REVIEWER COMMENTS

Aim of designing of microstrip rectangular patch antenna as an Ultra wide-band is to define an antenna for multipurpose for many different wireless applications and to evaluate the all parameters of antenna as like return loss, VSWR, radiation pattern, smith chart, gain and etc.

The main challenge in designing of microstrip rectangular patch antenna is to design a single antenna for different-2 wireless application using any feeding technique. In the base paper, An analytical study of the effects of different size and shapes of slots on the performance characteristic of UWB Microstrip antenna is presented. So, the main improvement should be done by making ultra wide band more wide so that it can be used for more wireless applications.

So the proposed formulation or algorithms will completely recognized the optimization of Multi (dual) band and UWB antenna for wireless technology using microstrip line feeding technique.

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