A Review on Various Techniques for Designing of Microstrip Patch Antenna

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ABSTRACT: Microstrip patch antenna is typically used in modern communication devices over usual antennas mostly due to their size. In this review paper, a survey is conducted on normally used techniques and design used in microstrip antenna papers which has been used by researchers for designing of an competent, low profile, small, friendly, affordable microstrip antenna, mainly used to designed multiband, wideband and reconfigurable antennas.

KEYWORDS: CPW fed Microstrip Antenna, Patch Antenna, Patch Antenna Designing, Review on Antenna Designing, Microstrip Patch Antenna etc

I.INTRODUCTION

In present scenario of wireless communication, recent developments in wireless communication engineering continue to derive prerequisite of small, compatible microstrip patch antennas. A patch antenna is a narrowband, wide beam antenna made-up by etching the antenna element model in metal trace bond to an insulating dielectric substrate like as printed circuit board with a continuous metal layer bond to the opposite side of the substrate which forms a ground plane [4].The EM waves is generated by an antenna which is so called tradiator because it converts the electric current in to Electro-Magnetic waves and by receiving EM waves and convert back to current [8]. Radiation takes place in an antenna by changing the current inside a conductor wire is the main concept of radiations by antenna. By accelerating or decelerating the current through straight wire, the current will create a flow which make the antenna radiate, if current will not flow antenna it will never radiate [15]. Regular microstrip antenna shapes are rectangular, square, circular and elliptical, but any continuous shape is feasible. The resulting structure is less uneven but has a wider bandwidth since such antennas have a very low profile, and is mechanically rugged [8]. They are often placed on the exterior of aircraft, spacecraft or are built-in to mobile radio communications devices like cell phones. Microstrip antennas are finest choice for wireless devices because of characteristics with low profile, low weight, simple in fabrication with low cost. Since it is common put into practice to combine numerous radios into one wireless and use same antenna. Microstrip antenna suffer from disadvantages like less bandwidth and gain [16]. For obtaining multiband and wideband characteristics, special techniques have been used like cutting slot in patch or fractal geometry [2] and Defect Ground Structure [10]. In order to increase bandwidth DGS has been used. DGS is realized by cutting shape from ground plane. Shape can be simple or complex. When DGS has been applied to antenna corresponding inductive part increases and this results in high effective dielectric constant hence bandwidth reduced. It is noted that within particular area of ground different DGS produces different resonant frequencies and bandwidth as well. In this paper, few more techniques are discussed and proposed work selected using different Defect Ground Structure for future.

II. LITERATURE SURVEY

Alsath et al.[5] proposed method to enhance the isolation in microstrip patch antenna arrays which is described in paper. A Defect is introduced in form of meander line resonator by creating defect identified as band notch function. Resonator is designed to obstruct surface current at resonant frequency of two patch antenna. This antenna provides an improvement in isolation by 16.5 dB with reduced edge to edge spacing having 7 mm. This design and simulation has been made out using antenna simulation software. The resonator is considered to obstruct the surface current at the resonant frequency of the two patch antennas united along H-plane and operating at frequency of 4.8 GHz. The inter element isolation to and fro the implementation of SMLR has been proposed.
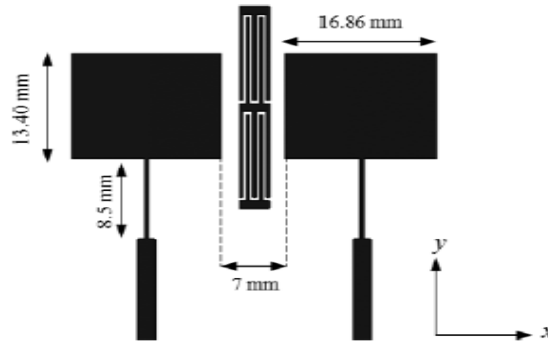
Fig. 1. Proposed patch with decoupling unit sandwiched between two patch antenna elements[5]

Khidrewt al. [6] proposed dual lobe microstrip antenna, two radiation beams were obtained in this design by operating patch at higher mode instead of fundamental mode. In this paper, the bandwidth of antenna is obtained by making U shaped patch geometry. Conventional U slot patch antenna, also analyzed with effect of U slot inclusion on performance of patch antenna was discussed. Antenna was designed and simulated using HFSS software and good results were obtained among practical and experimental results. The antenna operating frequency range is 5.15– 5.80 GHz with VSWR less than 2, which corresponds to 12% impedance bandwidth. It exhibits two radiation lobes, directed at 35 and with 7.92 dBi and 5.94 dBi realized gain, for 5.55 GHz.
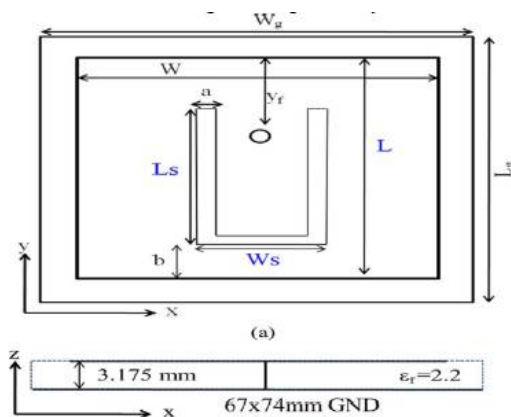

Fig. 2. Geometry of the proposed U-slot microstrip antenna: (a) top view; (b) side view. [6]

Further to this Nasimudin et al. [7] proposed a circular symmetric slotted structure microstrip patch antenna with compact size. The antenna was obtained by cutting shape in diagonal direction of microstrip patch antenna. . A measured 3 dB axial-ratio (AR) bandwidth of around 0.71% (6.0 MHz) with 2.1% (18.0 MHz) impedance bandwidth was achieved. The calculated bore sight gain was more than 3.2 dBi over the working band was obtained. Different shapes for the slots are studied and compare, on the basis of fixed on the whole volume of the antenna for circularly polarized diagonally slotted microstrip-patch antennas. This antenna designed to have compact size with small dimensions.

Next to it Liu et al. [8] proposed triband bowtie antenna using slot method. This antenna was achieved by inserting two pair of slot of different length of isosceles triangle without increasing area of triangle. Antenna is designed to operate for three different bands of wireless applications. Antenna has resonance at three different bands but its dimensions were made for centre frequency band. This antenna was resonated for 3.51 GHz, 4.5 GHz and 5.85 GHz. Design and simulation was done using antenna simulation software.
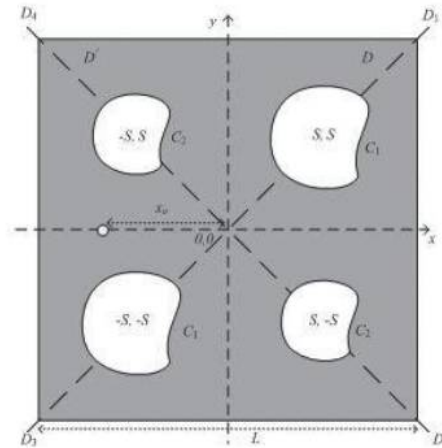
Fig. 3. Generalized at random shaped slots for diagonally symmetric slotted microstrip-patch structures. [7]
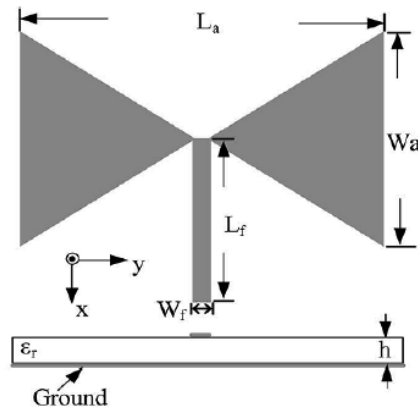

Fig.4. Geometry of the single-band bowtie antenna without slot (proposed parameters).[8]

Moosazadeh et al. [9] proposed a small and compact tri band microstrip fed monopole antenna for wireless local area network. This antenna was designed for wireless applications like WLAN/Wi-Max. The proposed antenna having a rectangular radiating patch with L and U shaped slots with ground plane. A study on the lengths of the U and L shaped slots was provided to obtain the operational frequency bands namely, WLAN (2.4/5.25/5.8 GHz) and WiMAX (2.5/3.55/5.5 GHz). The proposed antenna was small (15X 15X 1.6 mm).
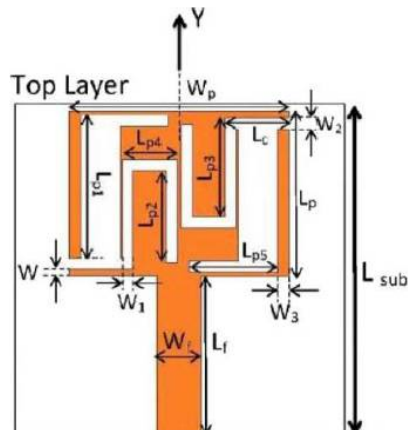

Fig. 5. Configuration of the proposed antenna.[9]

Sudipta Das et al[10] proposed a miniaturized slotted both on patch and ground plane for wideband operation The small antenna dimension is only about 24 X 22 mm , where, the resonant frequency of the usual antenna (i.e., 5.5 GHz). The measured outcome shows two resonant frequencies at 2.1 and 3.3 GHz. A 10-dB wide-impedance bandwidth of 3110 MHz ranging from 4.25–7.3 GHz is also achieved for the proposed antenna deisng. The measured result shows that the compactness of the proposed antenna reduced by 67% in related to the conventional rectangular microstrip antenna with same length, and the operating bandwidth is also enhanced up to 54%.
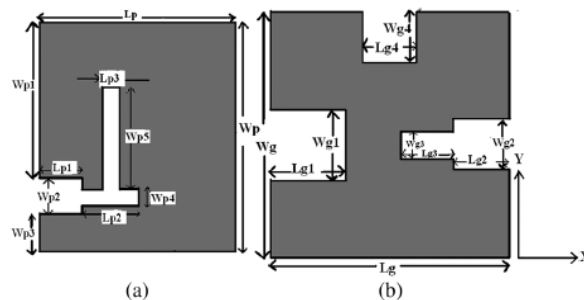

Fig. 6. Structure of the proposed antenna. (a) Patch. (b) Modified ground plane [10].

III. DESIGN TECHNIQUES ON FEEDING STYLE

The main challenge in designing a WB antenna is to cover larger bandwidth because the matching and energy transmission is required to be verified for the entire bandwidth. However, the traditional trade-offs such as size - efficiency and size - bandwidth still influences the characteristics and performance parameters of antennas. Some of the techniques discussed are following:

Microsrip line feed technique:

Compact design for microstrip antenna has been designed by variation in transmission line modal analysis. By this rectangular patch antenna parameters is calculated. It can support larger bandwidth excited by a time domain pulse to ensure better transmission and reception of WB signal. For providing further enhancement of the antenna performance in terms of impedance matching in bandwidth range stepped-matching technique is applied on the antenna.

Proximity coupled feeding technique: A single-layer microstrip antenna is one of the baisc examples for proximity coupled fed microstrip antenna in which arrays of rectangular microstrip patches were arranged in the log periodic way and proximity-coupled to the micro-strip feeding line. A large scale factor of 1.1 was first reported and proved highly effective to reduce the number of microstrip patches in the WB log-periodic arrays. The impedance bandwidth (measured VSWR< 2.5) of an example antenna is from 2.26–6.85 GHz with a ratio of near about 3.03:1. Very low-profile and low fabrication cost, suitable for various broadband applications.

Aperture coupled feeding technique: An aperture coupled fed micro -strip patch antenna has been examined along with a rectangular patch on top of two slots above the ground plane. There is a feed-line of having impedance 50 divided into two 100 feed line below the ground plane by microstrip power divider.

IV. DESIGN EQUATIONS

After the selection of three parameters based on application, i.e. frequency of operation, height of substrate and permittivity of dielectric material, next step is to calculate width and length of the patch.

Step 1: Calculation of Width (W)

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}} \sqrt{\frac{2}{\varepsilon_r+1}} \qquad\qquad 1$$

where, μ_0 is the free permeability, ε_0 is the free space permittivity and ε_r is relative permittivity.

Step 2: Calculation of Effective Dielectric Coefficient (ε_{reff}) the effective dielectric constant is

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}[1 + 12\frac{h}{W}]^{1/2} \qquad\qquad 2$$

Step 3: Calculation of Effective Length (L_{eff})

The effective length is

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}} \qquad\qquad 3$$

Step 4: Calculation of Length Extension (ΔL)

$$\frac{\Delta L}{h} = 0.412 \frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{rff} - 0.258)(\frac{W}{h} + 0.8)} \qquad\qquad 4$$

Step 5: Calculation of Length of Patch (L)

The actual length of radiating patch is obtained by

$$L = L_{eff} - 2\Delta L \qquad\qquad 5$$

Step 6: Calculation of Ground Dimensions (Lg, Wg)

$$L_g = 6h + L \ , \ W_g = 6h + W \qquad\qquad 6$$

V. CONCLUSION

This paper provides the review and survey of techniques of design for the designing of effective microstrip patch antenna. By using one of any above technique some of the limitations of basic microstrip antenna characteristics can be improved. This work is carried out on some characteristics implemented via different techniques. Nevertheless, useful solutions are still very less and suffers with different problems like difficulty of structure, less bandwidth, less in gain etc. Hence, the author feels that further research is needed in these areas.

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