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A critical review on micro-strip patch antenna design

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Abstract

The micro-strip patch antennas has advantages over conventional antenna because of this is it widely used in conformal, compact, and low- cost wireless applications. The literature survey of last decades of micro-strip patch antenna demonstrates that the different method is used to plan a small size micro-strip patch antenna. In this manuscript a review is conducted on different antenna designing techniques like, Fractal geometry, slot cutting, G shapes , edge tapering, and H shape.

Keywords: Bandwidth improvement; edge tapering; Micro-strip patch antenna.

1. Introduction

An antenna is a very significant device in wireless uses. A micro-strip aerial consists of a substrate that is squeeze in between patch and ground. The patch in the antenna is complete of a conducting material i.e. Cu and Au and this can be in any shape of circular, triangular, rectangular, elliptical. A simple Micro-strip patch antenna is consists of a radiating patch on one side of a substrate and a ground plane on the other side. The radiating patch and the feed appearance are usually photo etched on the dielectric substrate.

Micro-strip antenna consist of a number of advantages which are in low profile, small size, low weight but have a number of shortcoming like low gain, low bandwidth. Hence instead of improving this, fractal geometry has been useful on patch of antenna. The fractal geometry composed self-similar arrangement. Whenever fractal geometry is applied cuts are generated on patch which origins current flow direction change to occur. Therefore antenna resonates at different frequency bands. There are a figure of bands at which antenna may work. These bands are X, L, C and S band. Whenever fractal geometry is useful, antenna can be helpful for number of uses like communication, GPS, Radar, GSM, satellite. There are dissimilar fractals geometries that can be used but most commonly used geometry are Koch, and Minkowski. Further with increase in number of iterations, size of antenna reduces. By providing a number of slots over the scrap, bandwidth is better of patch antenna. Due to the presence of multiple slots, The Q factor reduces and value of patch inductance boost. By the reduction in Q factor, the BW of patch antenna is amplified accordingly,

2. Literature review

K.Sankar et al. proposed a circular polarized dual band G-Shaped patch antenna using HFSS. By using four slots on patch antenna he designed a G shape on patch. By using slot cutting on patch shape of the patch get changed. This will cause to create discontinuity for the electric field and hence it will increase the band width. By introducing G-shpe on the patch antenna it will resonated at two frequencies at 3 and 3.8 GHz having 7.5 and2.4dBi gain respectively.

R. K.Sharan et al. 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 he used partial ground. 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%.This antenna also have good radiation pattern with a gain of 2.65dB and having 83.9% radiation efficiency.

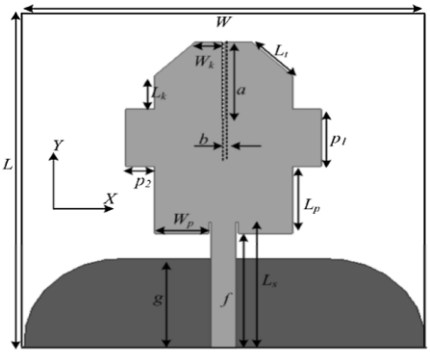

Fig.2: 2D view of proposed antenna with slot and parasitic stub [All dimensions are in mm: L = 35, W = 35, a = 8, b = 0.2, f = 12, g = 9.4, Ls = 13.2, Wp = 4.175, Lp = 7,Lk = 3.5, Wk = 2.4, Lt = 4.95, p1 = 6, p2 = 2.5

In this the edges of the two corner of the patch have been removed this will eliminate the stray electric field the proposed antenna used FR4 Epoxy Glass as a substrate material. Having thickness of 1.6mm

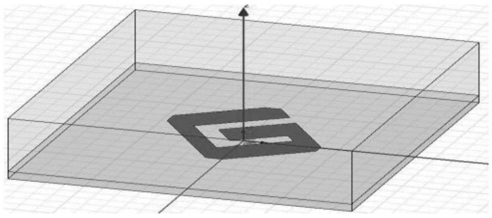

Fig. 3: Completed design of proposed antenna in HFS

Subhrakanta Behera et al. proposed a Multi port network approach for the analysis of dual band fractal micro-strip antennas. To analyze the behavior of micro-strip fractal antenna, multiport network approach is used. It has been observed that by increasing the indentation factor in the fractal section of the radiator, the resonance frequencies of the antenna changes and by suitably choosing this value one can get an antenna design with improved bandwidth with good gain at both the resonance frequencies. .

Reza Zaker et al. proposed anovel modified micro-strip-fed ultra wideband(UWB) planar monopole antenna with different frequency band-notch function. In this paper two slots are inserted on both sides of the feed line on the ground plane .This will increase the bandwidth of the patch antenna. In this antenna the patch had been cut in the H- shape. By introducing the defected ground (DGS) the inductance and capacitance get changed which will increase the antenna bandwidth. The proposed antenna is implemented on FR4 substrate with thickness of 1.0 mm with dielectric constant of 4.4.Also the additional current path was provided by the DGS.

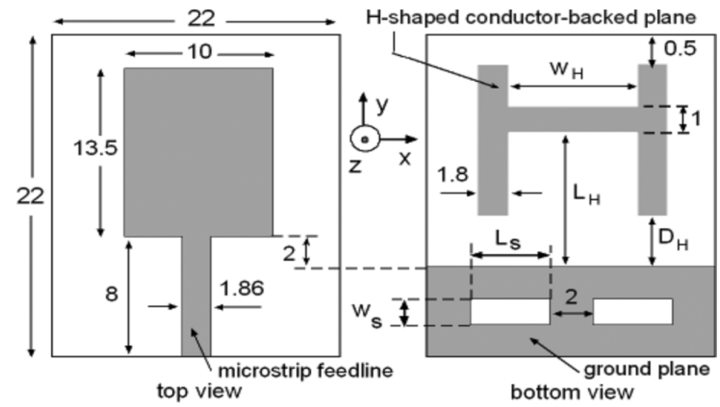

Fig.4: Geometry of the proposed planar monopole antenna

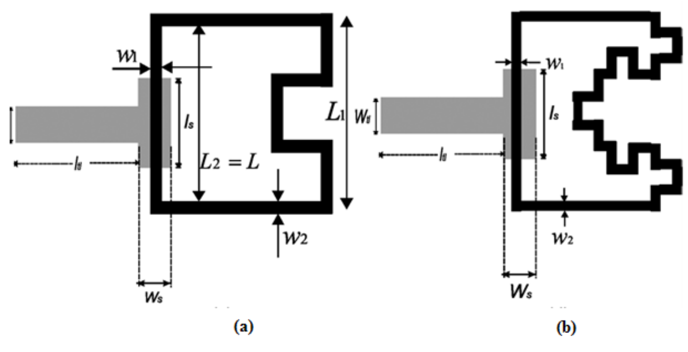

Fig.5 a) Antenna with 1st iteration fract 5 (b) Antenna with 2nd iteration fractal

In this paper the length opposite to the feed line restore with Minkowski geometry. In the 1st iteration center part of the line gets removed and parameters of the antenna like gain, return loss and radiation pattern was calculated. In 2nd iteration same process was repeated and the patch shape becomes as shown in fig 5 (b).Ground plane used a dimension of 20×20cm^2 using aluminum materials. This antenna was designed in IE3D software. By using iteration the bandwidth of antenna get increased.

Ajay Yadav et al. represent designing & analysis of E-shape micro-strip patch antenna for wireless communication. The advantages of this antenna were low volume, low profile configuration, easily mounted, light weight, low fabrication cost. The antenna operate on 3.1GHz and 3.45GHz frequencies. The proposed antenna is implemented on the FR4substratewith dielectric constant 4.2 and thickness of 1.6mm. To improve the bandwidth two slots which are parallel to each other are cut which provide additional current path. It has been observed that the position of feed points effect the performance of the designed antenna. The E-shape design has return loss of -12dB of and -28dB at operating frequencies 3.1GHz and 3.45GHz respectively. To simulate the results of designed antenna HFSS software is used.

R. Ghatak et al. proposed a wideband fractal shaped slot antennas for X- band application. A novel fractal patterned iris loaded cross dipole slot antenna along broad wall of rectangular waveguide at X- band is designed. To improve the impedance matching, the method of junction tapering of the cross slots is used. Bandwidth enhancement better than 2 GHz is achieved with optimization of iris depth and inclusion of a second iteration slot in the primary cross slot. Peak realized gain remains around 7 dBi over the operational bandwidth.

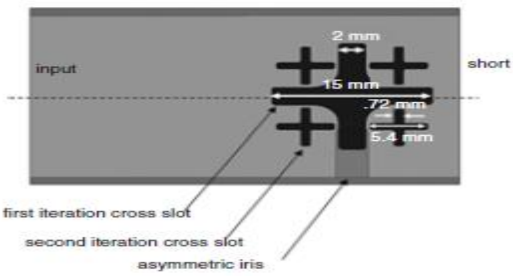

Fig.6:Structural layout

A pattern and impedance bandwidth better than 2 GHz (9.6 to 12 GHz) is observed with a second iteration cross dipole fractal shape centered slot antenna loaded with a curved partial height iris of 4 mm thickness and 7.2 mm depth .

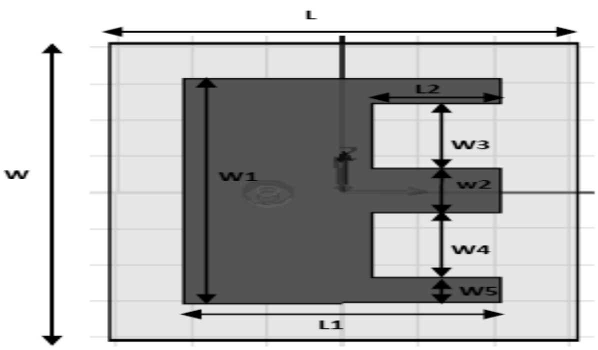

Fig7: Geometry of proposed Antenna

Alak Majumd et al. represents a rectangular micro-strip patch antenna using coaxial probe feed which was operated in S band that is from 2 to 2.5 GHz. This antenna had partial ground plane using Fr-4 substrate with dielectric constant of 4.4 and thickness of 1.6mm.The resonant frequency 2.25 GHz was selected that can be taken by taking the arithmetic means of higher and lower frequency that is 2 and 2.5 GHz. By calculating the values of width, length of the patch by using equations as mentioned in the antenna design we design the antenna using Hfss.

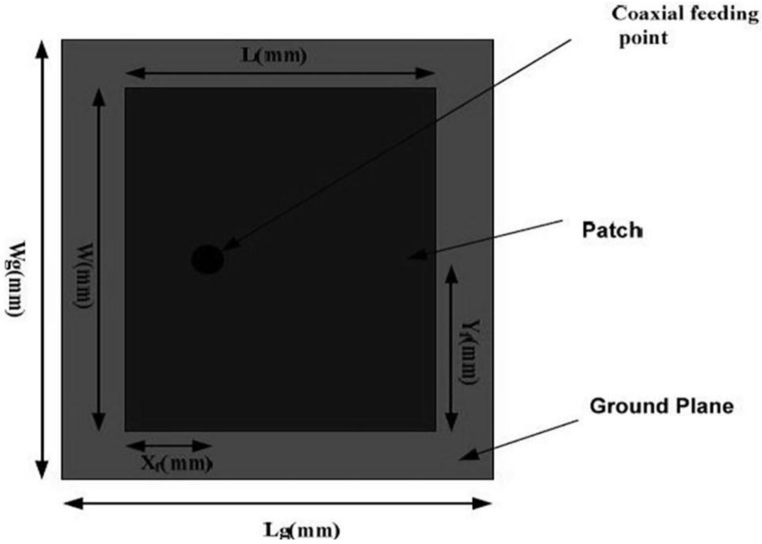

Fig. 8: Proposed Rectangular Micro-strip Patch Antenna

3. Antenna design

Steps involves in antenna design are given as under:

Step 1: The width of the microstrip patch antenna

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

Step 2: Determine effective dielectric constant, ε_{reff} ,

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

Step 3: Calculate the length extension ΔL

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

Step 4: Determine the patch length

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

Where the effective length of the patch L_{eff}

$$L_{eff} = \frac{\lambda_0}{f_o\sqrt{\epsilon_{reff}}}$$

Step 5: Now calculate the dimensions of ground

$$L_g = 6h + L$$

$$W_g = 6h + W$$

4. Conclusion

This study offered an imminent on decide the behavior of micro-strip patch antenna by different designing methods like E shape, fractal, cross dipole slot, edge tapering, G shape, and parasitic stub. The limits of conformist antenna can be conquer by use of the above mention methods. The highest value of output parameters increase by using G- shape method and return loss by using E-shape method is 7.5 dB and -28 dB. The method discussed in this manuscript is based on different methods to simulate the various parameters of the antenna.

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