A Compact Multiband Micro Strip Patch Antenna for Wireless Communication

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Abstract— This paper presents; a compact design of the micro strip patch antenna is based on the cloud shape. The proposed antenna is operating in C and X band with the return loss of -19.07 dB, -24.2dB, -12.6 dB and 21.10dB at the resonant frequencies 7.5 GHz, 9.2 GHz, 10.0GHz and 11.7 GHz respectively. The antenna offers the maximum gain 9.1dBi at 9.2GHz. The proposed antenna's characteristics such radiation patter, gain and return loss plays the important role to improve the performance of the antenna compare to the conventional antenna for various C and X band application. Cloud shaped based antenna is being designed using G-10 ($\varepsilon = 4.8$) substrate on the finite size of the ground plane. Simulated result is being obtained using the CST (computer simulation technology) microwave studio tools.

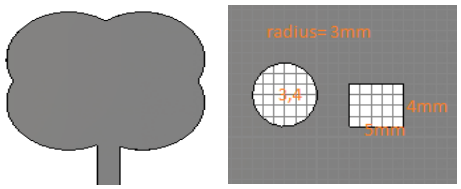
Key words: CST, Antenna Design, Simulated Result Discussion and Current Distribution

I. INTRODUCTION

In modern communication system, antenna is a very important component over a long distance communication. Different type antennas have been designed for use in different frequency band's applications [1, 2, 3, 4]. Such type antennas are different shapes and made of both perfect conductors and the dielectric materials. The antenna's parameter underlying the behavior and different design are based on the major requirements in communication system [5, 6, 7, 8]. In resent time, demand of such antennas which are light weighted, low cost, highly gain and low fabrication complexity [9, 10, 11, 12, 13]. The primary goal of the researcher is to design the antenna which shows the greater acceptance with the resent communication system technology [14, 15, 16, 17]. In this work, a compact design of the micro strip antenna is being proposed which is operated in C and X band (6.5GHz- 12.5GHz). The proposed antenna geometry shows the significance performance in satellite and radar communication system for missile guidance, marine and short range tracking. The main characteristics of the proposed antenna include symmetric radiation pattern with low side lobes and higher gain. The main purpose of this paper is producing a compact structure of multiband micro strip antenna which provides the wireless communication. The antenna has a low cost solution and relativity easy to manufacture on the standard G-10 substrate. This simple design provides the major advantage on the printed circuit board. By selecting shapes and dimensions of defecting ground, feed and the cutting slots properly, good multiband impedance bandwidths, gain and significance radiation characteristics for use in C and X-band (6.5–12.5 GHz) applications could be obtained. The effects of the cutting slots on the antenna performance were studied. The proposed antenna geometry not only shows good multiband operation performance and radiation pattern but also a simple structure and compact size. The proposed antenna design and the simulation result discussions in the following section.

The paper is organized as follows. Section II presents the noble design of the proposed antenna while gain and radiation characteristic is shown in III section. IV section attempt the surface current distribution discusses the novel design of the proposed findings and results respectively. Section IV discusses about the conclusion.

II. ANTENNA DESIGN AND ARCHITECTURE



(a) Front views (b) Back view

Fig. 1: Proposed antenna geometry

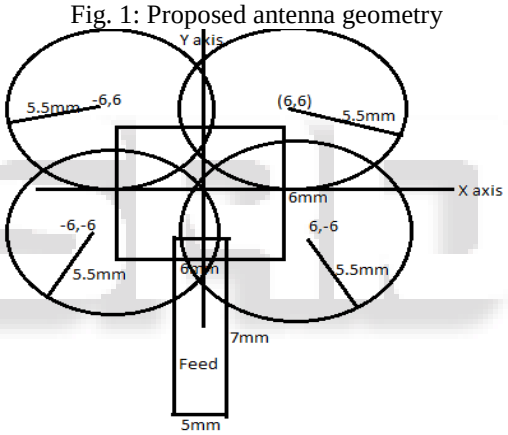


Fig. 2: Internal architecture of the proposed antenna

The proposed antenna geometry and configuration is depict in "Fig. 1," and "Fig. 2," Initially, a square shape of the patch is designed on the G-10 substrate having relative permittivity equal to 4.6 and thickness equal to 1.6 mm. The dimensional configuration of the patch and the substrate is made up of PEC (Perfect Electrical Conductor) are 6 x 6mm and 28 x 22mm respectively. Then, the four circles of the equal radius and equally separated are organized on the same level which play the important role to agitate significance radiation pattern distribution. The overlapping area of the whole component (circles, rectangle and the feed) of the patch is responsible for maximum current density due to current adding nature. Such configuration is provides the Cloud based antenna is illustrated in "Fig. 2,". The antenna input is provides by rectangular feed with the dimensional of 5 x 7mm. the defected ground plane is dedicated to performance of proposed antenna geometry in C and X band applications. Two slots with the different shape one as circle with the radius 3mm and centre (0,0) and another as rectangular shape with the dimensional 5 x 6mm are embedded in the ground plane is shown in fig:1(b) as well.

III. RETURN LOSS

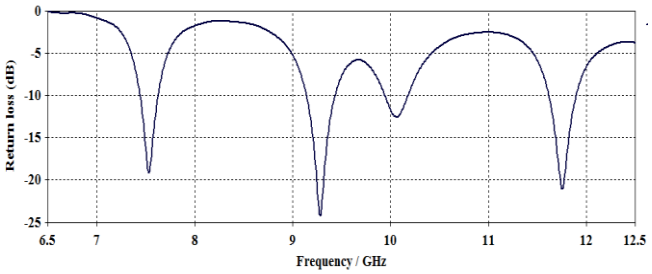
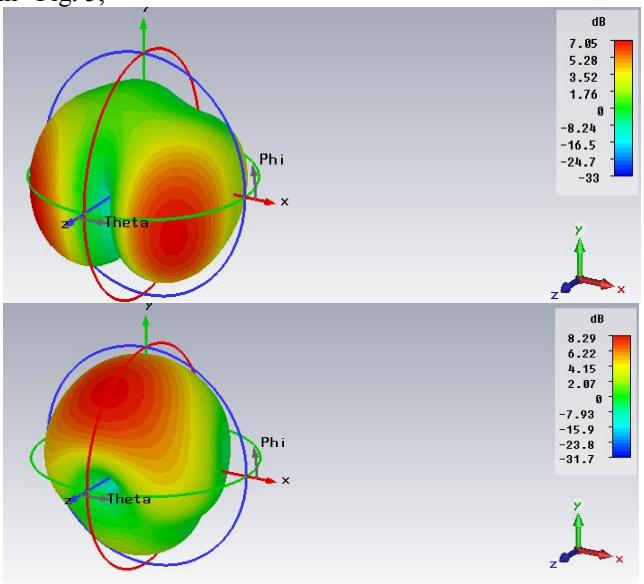


Fig. 3: Variation of the return loss with Respect to the frequency

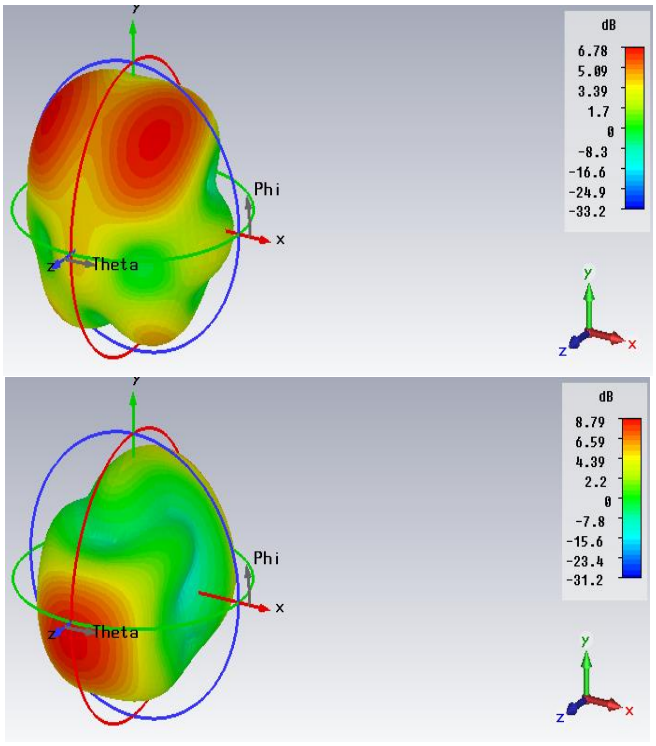
The variation of the return loss with respect to the frequency is shown in "Fig. 3," the simulated result is obtaining using CST software. The proposed antenna geometry is resonant at the 7.5 GHz, 9.2 GHz, 10.0GHz and 11.7 GHz. Its offers the high value of the return loss parameter -24.2dB at the second resonant frequency. The proposed antenna is resonating at multiple frequencies which provide the excellent return loss is less than -10dB.

IV. GAIN AND RADIATION CHARACTERISTIC

The 3D gain characteristic of the proposed antenna at the resonant frequencies is shown in figure.4. At first resonant frequencies, the antenna gain is maximum at two top view with the equal angle to the Z axis is shown "Fig. 4(a)," The red circular spot tends to the maximum gain contribution which is indicated by the gain (db) scale, its value is 7.05 dB. A small amount of the current appears at the middle view. Such gain pattern shows the satisfactions result in C band application. At the second resonant frequency, maximum gain existence at the mid of the Y and Z axis while it is maximum in the Z axis at 11.7GHz.The proposed antenna offers the maximum gain at the third resonant frequency is shown if fig. "Fig. 5(a),". The gain is distributed in whole direction, its shows the isotropic characteristic of the proposed antenna geometry in term of the gain (6.78db). In 2D gain configuration, the value of the gain is 7.2db, 8.1db, 6.7db and 8.81 with respect to the resonant frequency. The maximum gain provides by antenna 9.1dB at nearly third resonance frequency 10GHz as shown in "Fig. 5,"



(a)



(b)

Fig. 4: 3D gain configuration at resonant frequincies (a)7.2GHz and9.2GHz, (b)10GHz and 11.7GHz

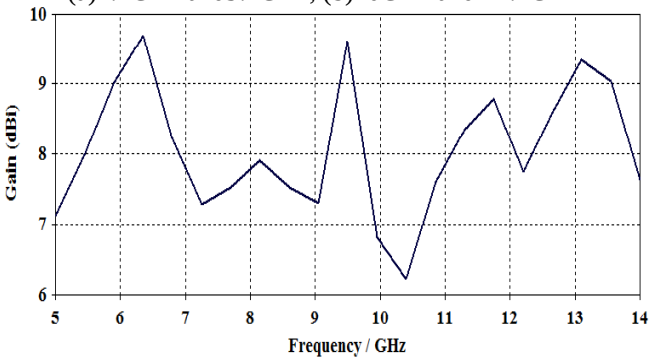
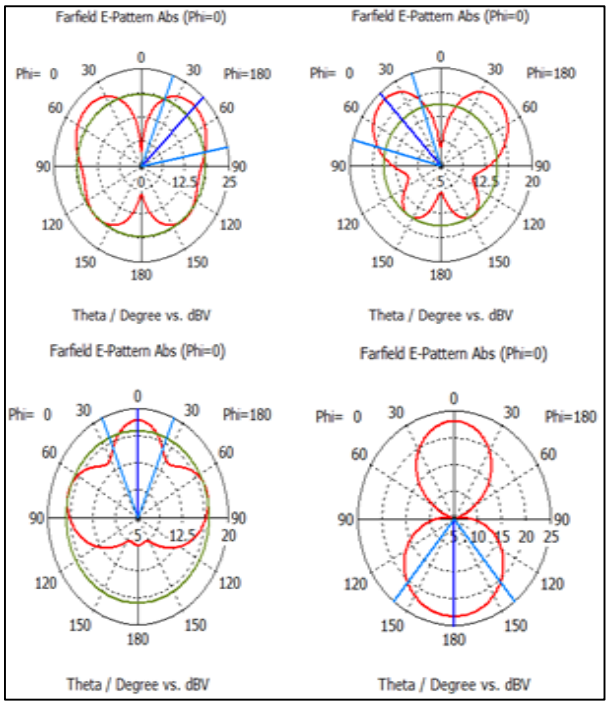
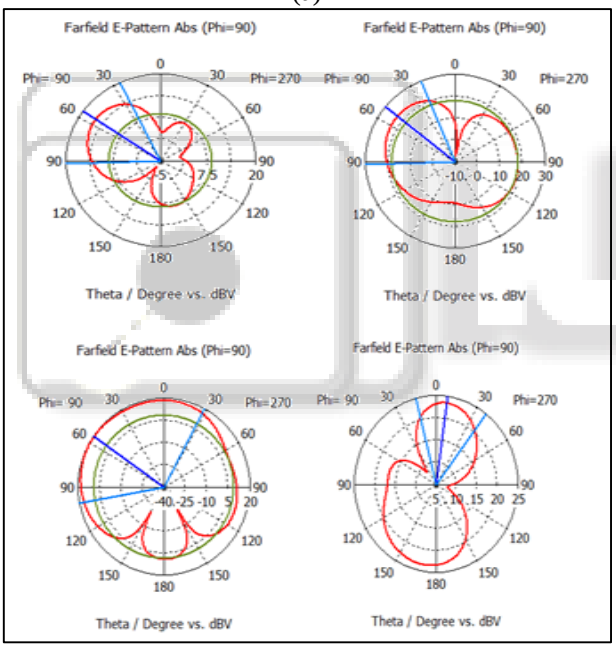


Fig. 5: 2D Gain Configuration with respect to the frequency (GHz)

The E and H plane radiation pattern are shown in "Fig. 6,". at first and the second resonant frequency E plane elevation radiation pattern is tilt at the ± 45^0 and two minor lode appears at the opposite direction of the major lode while third and fourth resonant frequency, existence of maximum radiation pattern direction perpendicular to the patch geometry, its shows the bi directional nature of the antenna at these frequency is shown in "Fig. 6(a),".. In H-plane pattern, the direction of the major lobe at 60^0 with the patch geometry at 7.2GHz and 9.2GHz. The H plane radiation characteristic is almost same with the E plane radiation pattern at the 10GHz and 11.7GHz frequency is depict in "Fig. 6(b)," Such type of radiation patterns shows a good agreement with the essential requirements in C and X band application. The omnidirectional radiation pattern makes that the proposed antenna a suitable candidate for X-band applications [18, 19, 20].

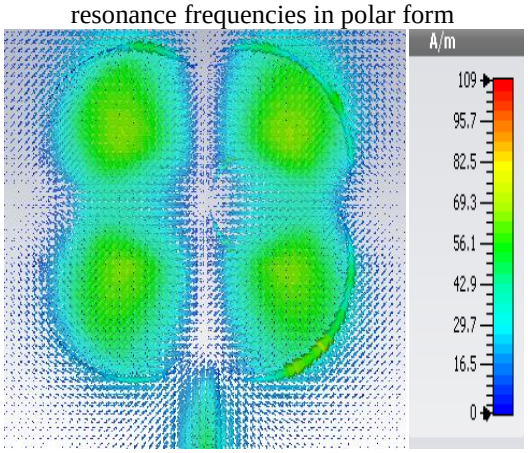


(a)



(b)

Fig. 6: Elevation radiation pattern of E (a) and H plane (b) at resonance frequencies in polar form



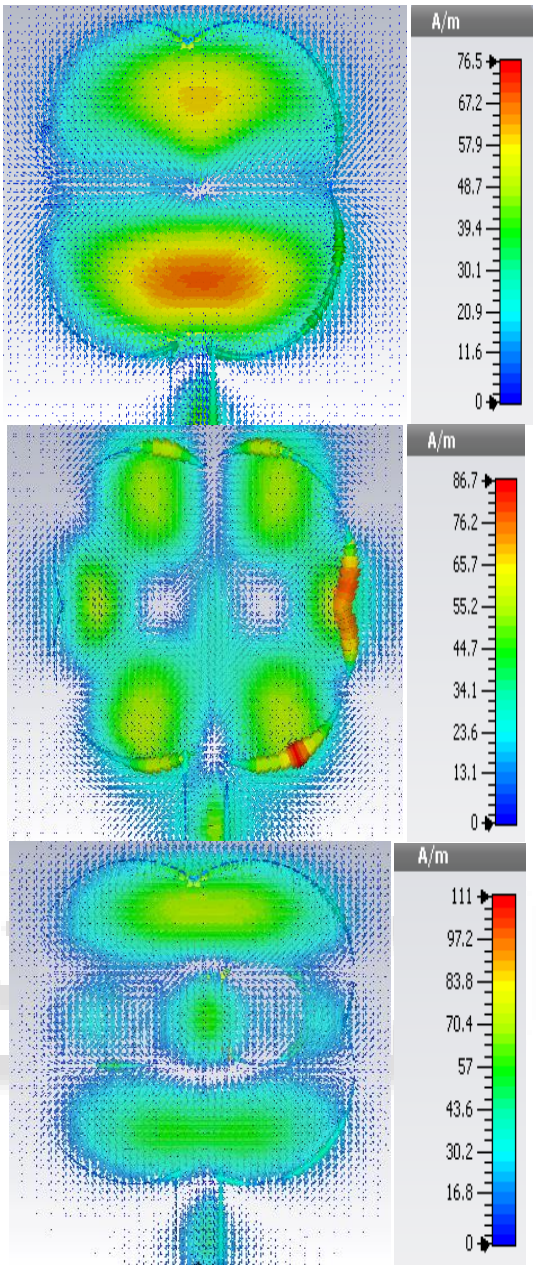


Fig. 7: Surface Current distribution profile of proposed antenna at 7.2GHz, 9.2GHz, 10GHz and 11.7GHz

The surface current distribution on the patch of the proposed antenna geometry is shown in "Fig. 7,". At first resonant frequency, a less amount of the current density appears at the center of the circles and boundary of the patch, while a sufficient quantity of the current flows at the overlapping area of the patch components at the second resonant frequency. The maximum current distribution appears at the third resonant frequency. The red spot indicates toward the maximum current symbol, it is maximum at total geometrical area of the individual circles and its boundary as shown in "Fig. 7(b)," By deep examines, the current is also maximum at the feed position. The lightly yellow spot appears at the top view of the patch at 11.7GHz frequency.

V. CONCLUSION

In this paper, a compact cloud based micro strip antenna is being proposed. The proposed antenna design is simulated using CST microwave studio tool. A simple construction,

adjustable radiation pattern, and moderate gain are some of the key features of this new design. The simulated result has been analyzed in C and X band application. Radiation character and surface current distribution exhibits the best features of this antenna which provides the satisfaction performance in wireless application such as radar and satellite communication system. Detailed current distribution analysis is also provided in this paper to understand the underlying mechanism which could be important in designing proposed antenna geometry.

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