Proceedings of ISAP 2014, Kaohsiung, Taiwan, Dec. 2-5, 2014

Unsymmetrical Angular Axial Ratio Distribution Elliptical Polarization Antenna

Ta Chun Pu[1], Chun Yih Wu[1], and Yen Liang Kuo[1]
[1]HTC, No. 88, Sec. 3, Zhongxing Rd. Xindian Dist., New Taipei City 231, Taiwan

***Abstract* - An elliptical polarization antenna with unsymmetrical angular axial ratio distribution is proposed in this work. The RF current distribution on radiation patch is redistributed to increase the angular axial ratio variation. This property can suppress the received signal strength from unwanted direction. It's suit for point to point communication and radar application. Details of the antenna design are shown, and the measured results for the constructed prototype are also exhibited and discussed.**

***Index Terms* — Elliptical polarization, Unsymmetrical axial ratio, Slits.**

I. Introduction

Typically CP antenna is utilized to solve the fading RCS problem in radar system. Circular polarization (CP) is implemented such that reception from any polarization angle can be maintained [1]. Polarization mismatch caused by axial ratio difference between two antennas also can be utilized to suppress the clutter signal. The clutter suppression mechanism in this paper can be explained in figure 1. As the angular offset from main beam direction increased, the polarization mismatch is increased but the antenna gain is decreased. Thus received signal strength from unwanted direction can be suppressed and the signal to noise ratio can be enhanced. It is more difficult to determine the polarization mismatch loss when transmission and receiving antenna are elliptical polarization. Although equations in reference [2] can be used for estimating the polarization loss, it's still need to be measured directly in realistic environment.

This paper is organized as follows. First, the antenna geometry including detail of structure is described. Second, simulated RF current distribution and axial ratio of proposed antenna are compared with typical CP antenna. Finally, proposed antenna is implemented and measured.

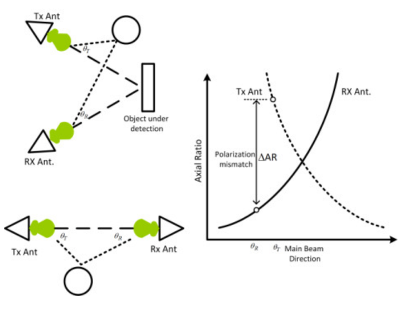


Fig. 1. AR and application of unsymmetrical AR CP antenna.

II. Antenna Configuration

The proposed elliptical polarization antenna is shown in figure 2. The width (W) of the ground plane is 100mm. The side length (L) and height (H) of square radiating patch are 33mm and 4.5mm. A side length 12.6mm (ΔL) at opposite corners is cut to obtain two orthogonal near-degenerate resonant modes for CP radiation [3]. The Slits and stubs on the other two opposite corners are 12mm (L_1) and 4mm (L_2) in length, both drag RF current at operation frequency band. Thus RF current density is redistributed and unsymmetrical angular AR distribution is obtained. Besides the return loss is improved by adding a symmetrical metal plate on the opposite the feeding plate side.

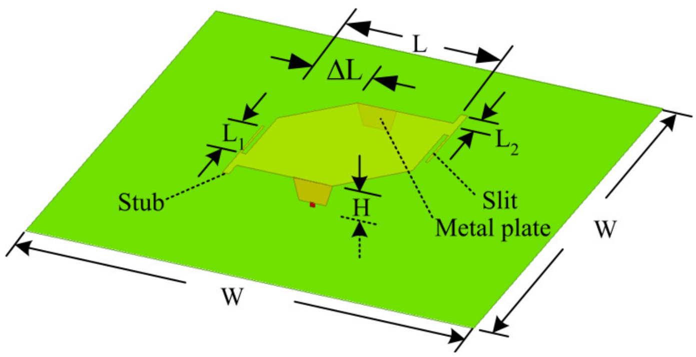
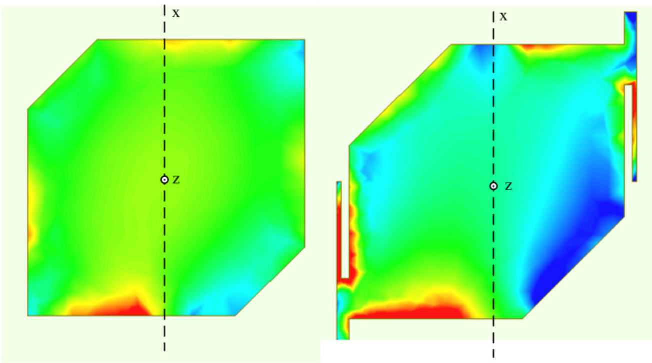


Fig. 2 Unsymmetrical AR EP antenna detail geometry

III. Numerical and Experimental Results

Figure 3 shows the simulated RF current density distribution of typical and proposed CP antenna in the same scale. The slits and stubs drag the RF current to the patch edge. Compared to the typical CP antenna, the current density of the proposed CP antenna is increased form the center to the patch edge. As shown in figure 4, the axial ratio (XZ cut) of proposed antenna are measured and compared to typical CP antenna, and the slope of axial ratio to degree curve increases form 0.53dB/10^{o} to 1.26dB/10^{o} with the slit and stub structures. As the slope increases, the input matching degrades. Additional metal plate (figure 3) is used to improve the return loss. The measured return loss of antenna is shown in Fig.5, and the return loss is improved about 2.3dB. As shown in figure 6, the simulated and measured antenna gain are 7.8dB and 7.1dBi. Finally the radiation pattern is still broadside pattern as $d\mathrm{AR}/d\theta$ increases.



(a) (b)

Fig. 3 RF current distribution (a) CP antenna and (b) Proposed unsymmetrical AR EP antenna.

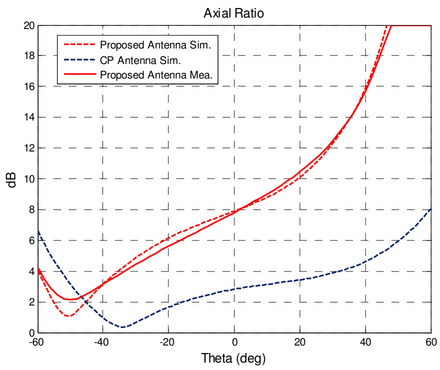


Fig. 4 Axial ratio of proposed antenna and elliptical polarization antenna

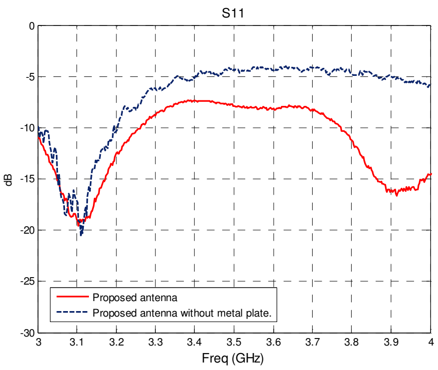


Fig. 5 Measured antenna S11

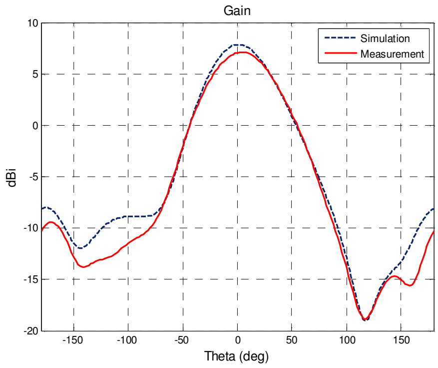


Fig. 6 Simulated and measured antenna gain

IV. Conclusion

In this paper, the proposed unsymmetrical AR EP antenna was numerically analyzed, fabricated and measured. The good agreement between the numerical and measured result was obtained. Compare to the typical CP antenna, the slope of axial ratio to degree curve increases almost 2.5 times with the slits and stubs. Due to the maximum gain and $d\mathrm{AR}/d\theta$ are in the same direction, the maximum unwanted direction signal suppression can be achieved. Our design can reduce clutter interference and multi-path effect to be a good candidate in radar and point to point communication.

References

[1] Chan, K.K.M., Tan, A.E. , Rambabu, K., "Elliptically Polarized Ultra-Wideband Radar System for Vital Signs Monitoring," *IEEE Trans. Antennas Propag*at., vol. 61, pp. 2069- 2075, 2013.

[2] Pike, Beuhring W., "Power Transfer Between Two Antenna with Special Reference to Polarization," *Technical Report AF WTR-TR-65-1*, 1965.

[3] P. C. Sharma and K. C. Gupta, "Analysis and optimized design of single feed elliptically polarized microstrip antenna," *IEEE Trans. Antennas Propag*at., vol. 31, pp. 949- 955, 1983.