Polarization Agile Antenna

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Introduction

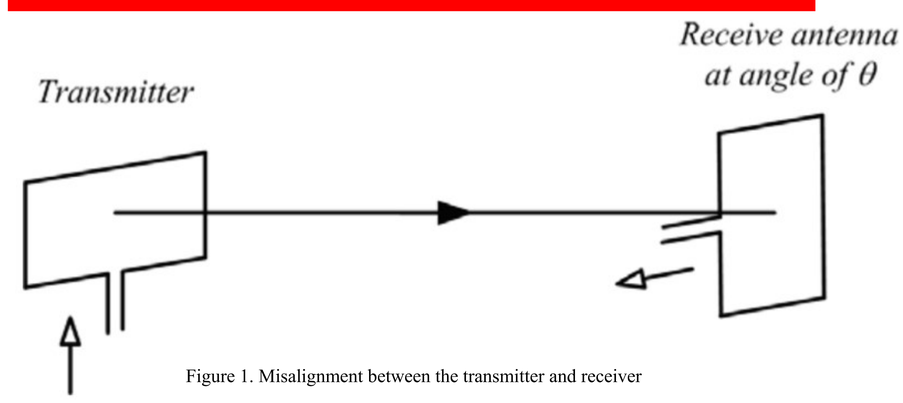

Figure 1. Misalignment between the transmitter and receiver

Linear polarization is widely adopted in modern communication system. But misalignment between transmitter and receiver may introduce loss. Using Mechanical Structure to adjust the antenna is slow and inaccurate. Therefore, we try to design a polarization agile antenna to change the polarization without mechanical movement of the antenna.

Principle

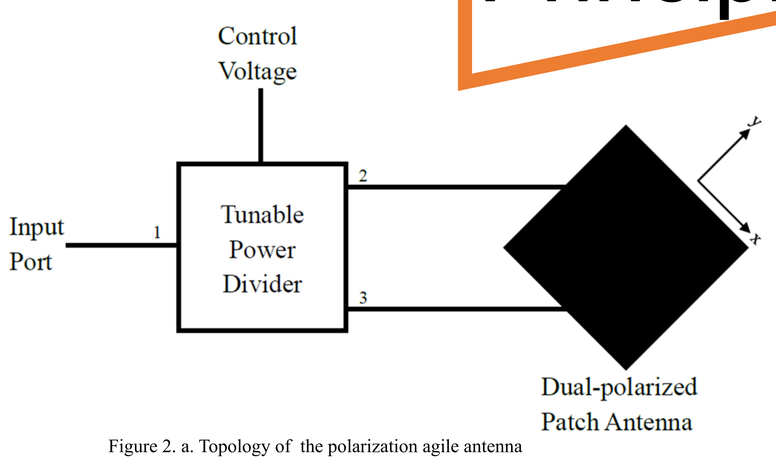

Figure 2. a. Topology of the polarization agile antenna

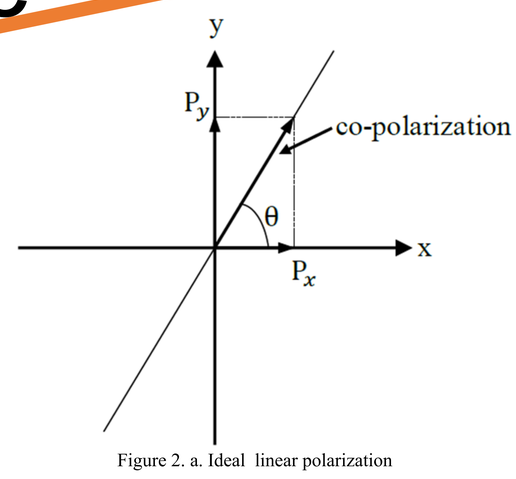

Figure 2. a. Ideal linear polarization

As shown in the above graph, input signal can be divided in the tunable power divider according to the control voltage. Wave from port 2 will be polarized along x-axis. Wave from port 3 will be polarized along y-axis. And the polarization of these two waves are orthogonal to each other. [1] As it's shown in Figure 2, if the signal from port 2 and port 3 are in phase, by adjusting the power ratio between P_x and P_y. We can change the polarization of the linearly-polarized over 90 degrees.

Measurement

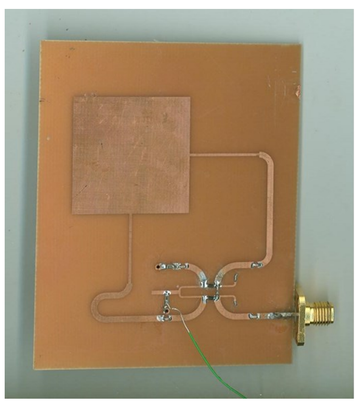

Figure 5.a. Photo of polarization agile antenna

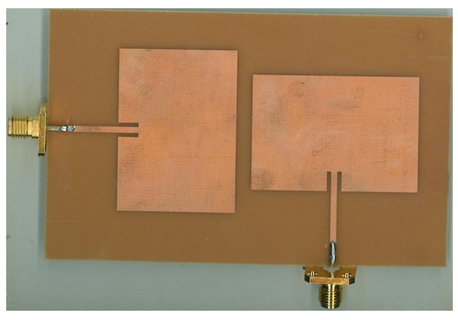

Figure 5.b. Photo of testing antenna

To measure the actual performance, A polarization agile antenna and a testing antenna is fabricated. Using network analyzer, it's shown that the center frequency of polarization agile antenna and testing antenna shifted to about 2.35GHz. Some other measurement results are shown as below.

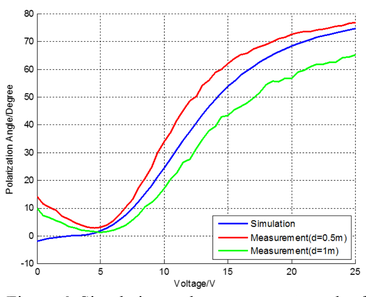

Figure 6. Simulation and measurement result of polarization angle versus control voltage

Control Voltage	Efficiency	Gain
0V	18.49%	-0.29dBi
10V	22.05%	-1.13dBi
13V	22.95%	-0.33dBi

Table 1. Efficiency and gain of the polarization agile antenna under some control voltages

Design

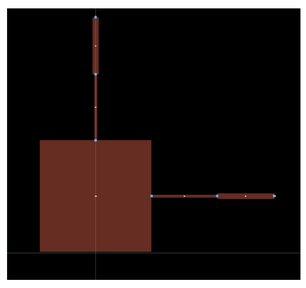

Figure 3.a. Layout of the dual-polarized patch antenna

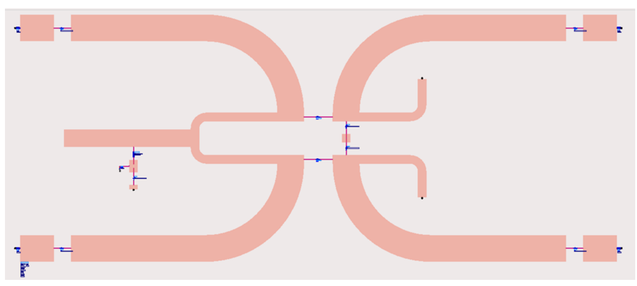

Figure 3.b. Layout of the power divider [2]

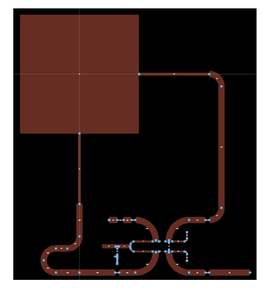

Figure 3.b. Layout of the polarization agile antenna

The dual-polarized patch antenna is basically a dual feed patch antenna adopting transmission line feeding method. Quarter wave length transformer are used for impedance matching. The power divider is based on a design called broadband rat-race coupler design with tunable power dividing ratio [2]. It has large power dividing ratio, large bandwidth, low insertion loss, high return loss and high isolation. The simulation result shows that the polarization agile antenna can successfully change its polarization angle according to the control voltage. As it's shown in the below pictures, when V=0v, the input power is mainly fed to the lower port, the antenna is polarized along vertical direction. When V=13v, the input power is equally divided, the antenna is polarized along diagonal direction. When V goes up further, the antenna will be polarized along horizontal direction.

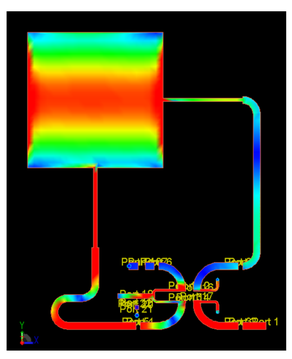

Figure 4.a. Momentum circuit excitation simulation result when V=0v

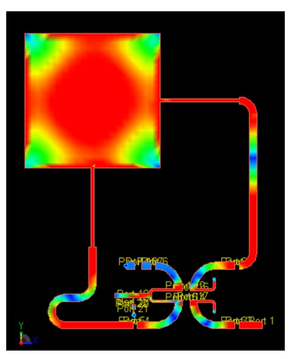

Figure 4.b. Momentum circuit excitation simulation result when V=10v

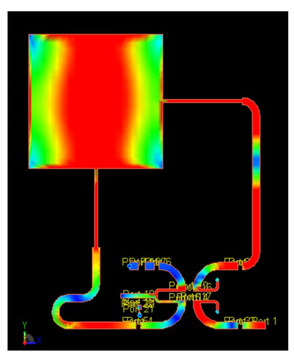

Figure 4.c. Momentum circuit excitation simulation result when V=25v

Conclusion

A polarization agile antenna with center frequency at 2.35GHz has been designed and fabricated.

The result shows that the it can change its polarization angle with different control voltage.

The range for polarization angle is about 0~75°, while the range for control voltage is 0~25V

Reference

[1] Ferrero, F., Luxey, C., Staraj, R., Jacquemod, G., & Fusco, V. F. (2007, November). Linearly-polarized tunable antenna. In Antennas and Propagation, 2007. EuCAP 2007. The Second European Conference on (pp. 1-5). IET.

[2] Cheng, K. K., & Chik, M. C. (2013). A Frequency-Compensated Rat-Race Coupler With Wide Bandwidth and Tunable Power Dividing Ratio. Microwave Theory and Techniques, IEEE Transactions on, 61(8), 2841-2847.

Acknowledgements

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