Element Power Balancing in Leaky-Wave Patch Arrays

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Circularly polarised microstrip patch leaky-wave antennas (LWA) have been demonstrated to be suitable for satellite communication systems [1], with gain enhancement capable of being achieved by adding extra elements onto the array. In practice, the benefit of this approach may be limited by uniform coupling gaps which yield non-uniform power distribution along the array elements. Consequently, for larger designs reduced radiation from the trailing elements contributes little to the resulting array performance or aperture efficiency.

In order to compensate for this, in this paper we varied the coupling gap between the patch elements and the feeding microstrip line so that the power radiated from each patch is balanced. Doing so has the effect of shifting the resonance of each patch as a product of a now locally varying coupling capacitance. Furthermore, the relative element phase can shift, when observed through surface currents on each patch, which alters the array's radiation pattern and axial ratio. To compensate for this effect, a spatially varying angular-slot is introduced into each element and explored through simulation in ANSYS HFSS.

A combination of varied microstrip patch coupling gap and compensation through adjusted slot orientation and dimensions was shown to both balance power delivered to the radiating elements whilst maintaining desired phase characteristics across the array. The return loss of the fed port is $< -10dB_{5GHz}$, with localised field solutions used to inform adjustments to the patch elements not readily seen from this metric alone. For a design at 5 GHz comprising 6 elements, a realised gain of 11.33 dBi with an axial ratio of 2.83 dB is achieved at zenith.

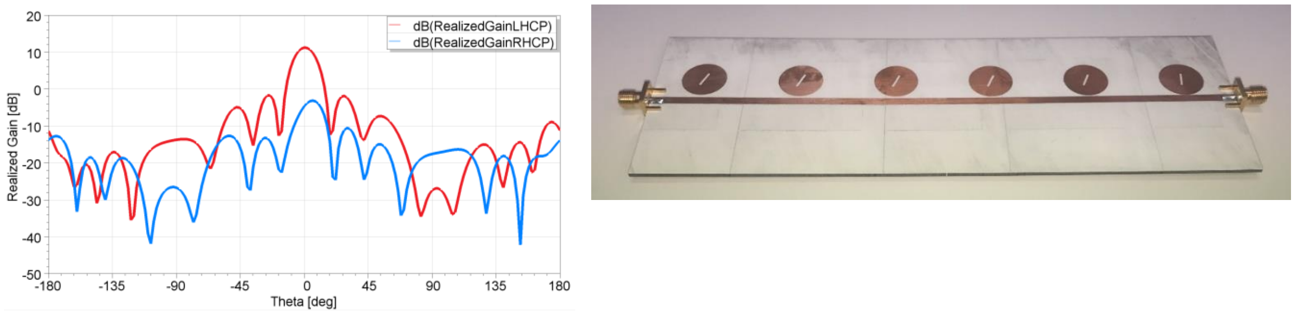

Fig. 1: LHCP and RHCP Realised Gain (5GHz) (a), Antenna as fabricated (b).

The fabricated antenna is measured at 5GHz using a spherical nearfield anechoic chamber showing the pattern seen in figure 2 (a), with a realised gain of 10.0 dBi and an axial ratio of 5.8 dB at zenith. Divergence in the predicted vs measured response is explored as a product of substrate variability. Further simulation studies indicate that this likely accounts for the observed behaviour.

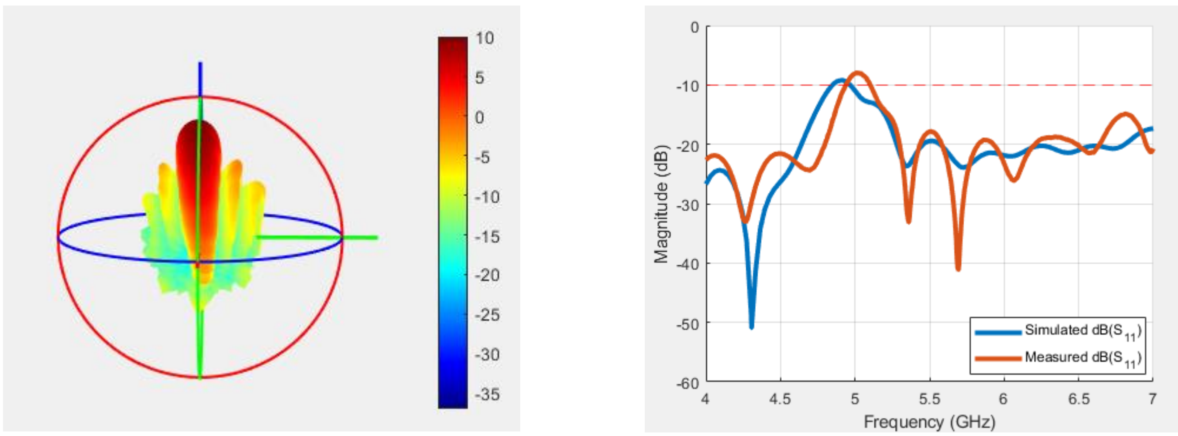

Fig. 2: Measured radiation pattern (a), simulated vs measured return loss (S11) (b).

[1] C. D. Bui, N. Nguyen-Trong and T. K. Nguyen, "A Planar Dual-Band and Dual-Sense Circularly Polarized Microstrip Patch Leaky-Wave Antenna," in IEEE Antennas and Wireless Propagation Letters, vol. 19, no. 12, pp. 2162-2166, Dec. 2020, doi: 10.1109/LAWP.2020.3026067.