Polarization Reconfigurable Sequentially-Rotated-Element Subarrays for Multifunctional Array Systems

Joshua M. Kovitz and Yahya Rahmat-Samii
Electrical Engineering Department
University of California Los Angeles, Los Angeles, CA, USA

Integrating multifunctional capabilities remains a strong priority for antenna arrays. Multifunctionality not only enables multiple system support, but it also serves as a platform to host future systems as the needs of communication and sensing evolve. Among pattern, frequency, and polarization adaptation capabilities, polarization reconfigurability is a feature that *must* be accomplished at the antenna element/subarray level. While a dual-polarized array could potentially achieve the same functionality as a polarization reconfigurable array, dual-polarization requires both dual-polarized elements along with another feeding network. This further complicates the design and makes a challenging feed routing problem. Further, the additional feed network can increase the weight and size of the system. High-performance polarization reconfigurable capabilities are extremely valuable, and further advancements can pave the way towards fully multifunctional arrays.

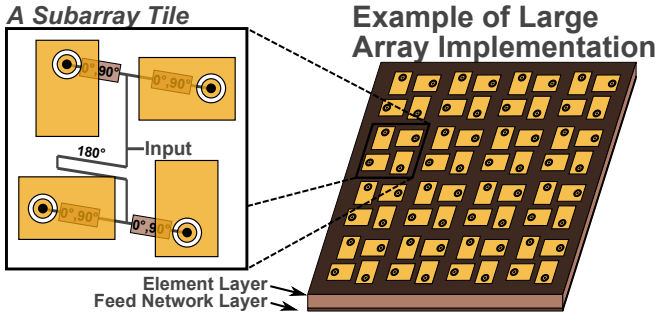

Figure 1: A sequentially-rotated-element (SRE) subarray tile. Polarization reconfiguration is achieved by placing binary $(0°, 90°)$ reconfigurable phase shifts before each element.

Previous research in polarization reconfiguration has primarily focused on the development of polarization reconfigurable elements, usually in single-radiator applications. While many polarization reconfigurable patch antennas have been presented in literature, bandwidth remains an important limitation where typical bandwidths have ranged from 1–20%. Simultaneous frequency-polarization reconfigurable systems have recently reached agility bandwidths of 46%. Our focus in this work is to investigate the possibility of reconfigurable sequentially-rotated-element (SRE) subarrays to match or outperform bandwidth (BW) support and losses without frequency agility. An example is illustrated in Fig. 1, where single-bit phase shifters are placed before each element to achieve potentially four orthogonal polarizations.

To this date, less than a handful of reconfigurable SRE designs have been presented. While the limitations of polarization reconfigurable single-element radiators are becoming well established, this study will shed light on whether superior performance can be achieved by SRE subarrays. By working at the subarray level, designers can implement advanced functionalities using both feed network and antenna elements with more real-estate. We will investigate optimal element designs and placement in addition to the possibility of using composite right/left-handed (CRLH) lines within the feed network for BW enhancements.