This dissertation explores the expansion of the electrically steerable parasitic array radiator (ESPAR) technology to arrays using microstrip patch elements. Scanning arrays of two and three closely-coupled rectangular patch elements are presented, which incorporate no phase shifters. These arrays achieve directive radiation patterns and scanning of up to 20° with maintained impedance match. The scanning is effected by tunable reactive loads which are used to control the mutual coupling between the elements, as well as additional loads which compensate to maintain the appropriate resonant frequency. The design incorporates theoretical analysis of the system of coupled antennas with full-wave simulation. A prototype of the three-element array at 1 GHz is fabricated and measured to exhibit a maximum gain of 7.4 dBi with an efficiency of 79.1%. Further, the microstrip ESPAR is thoroughly compared to uniformly-illuminated arrays of similar size.

To satisfy the need for higher directivity antennas with inexpensive electronic scanning, the microstrip ESPAR is then integrated as a subarray. The three-element subcell fabrication is simplified to a single layer with an inverted-Y groove in the ground plane, allowing for DC biasing without the need for the radial biasing stubs or tuning stubs found in the two-layer design. The 1 GHz ESPAR array employs a corporate feed network consisting of a Wilkinson power divider with switchable delay line phase shifts, ring hybrid couplers, and achieves a gain of 12.1 dBi at boresight with ±20° scanning and low side lobes. This array successfully illustrates the cost savings associated with ESPAR subarray scanning and the associated reduction in required number of phase shifters in the RF front end.

Approved for distribution by Prof. Xun Gong, Committee Chair, on March 11, 2013.

The public is welcome to attend.