As modern communication system technology develops, the demand for devices with smaller size, higher efficiency, and more functionality increases dramatically. In addition, highly integrated RF-front-end modules with a reduced footprint and less transition loss between cascaded devices are desirable in the most advanced wireless communication systems. Antenna arrays are widely used in wireless communication systems due to their high directivity and beam steering capability. Moreover, antenna arrays are preferred in mobile communication systems for diversity reception to reduce signal fading effects. In order to meet the various requirements of the rapidly developing wireless communication systems, low cost, compact multifunctional integrated antenna arrays are in high demand.

Reconfigurable antennas that can flexibly adapt to different applications by dynamically changing their frequency and radiation properties have attracted a lot of attention. Frequency, radiation pattern, polarization, or a combination of two or more of these parameters in reconfiguration of antennas was studied and presented in recent years. A single reconfigurable antenna is able to replace multiple traditional antennas and accomplish different tasks. Thus, the complexity of the wireless communication system will be greatly reduced with smaller size. On the other hand, the integration of antennas with other devices in wireless communication systems that improves the efficiency and shrinks the size is a growing trend in antenna technology. Compact and highly efficient integrated filters and antennas were studied previously. Studies also show that by seamlessly co-designing filters with patch antennas, the fractional bandwidth (FBW) of the antennas can be enhanced. However, the advantages of both the reconfigurable antenna and integrated filter/antenna technology have not been fully applied to antenna array applications. Therefore, this dissertation explores how to maximize the antenna array performance using reconfigurable antennas and integrated filter/antennas. A continuously frequency reconfigurable slot-ring antenna/array with switches and varactors is presented first. By changing the function of the loaded switches, the reconfigurable slot-ring antenna/array is able to operate as an L-band slot-ring antenna or a 2×2 S-band slot-ring antenna array. In each frequency band, the operation frequency of the antenna/array can be continuously tuned with the loaded varactors. To further enhance the functionality of the reconfigurable slot-ring antenna array, a dual-polarized fractal-shaped reconfigurable slot-ring antenna/array is developed with a reduced number of switches and an increased FBW. Additionally, ground plane solutions are explored to achieve single-sided radiation. The benefits of filter/antenna integration are also investigated in both linearly polarized patch phased arrays and circularly polarized patch antenna arrays. Finally, a preliminary study of a tunable integrated evanescent mode filter/antenna is conducted to validate the concept of combining reconfigurable antennas and integrated filter/antennas.
The public is welcome to attend.