ABSTRACT

The attractive features of an array antenna are high gain, small beam-angle, a large variety of radiation patterns, controlled sidelobe levels, and the scanning capability of the main beam or radiation null. However, mutual coupling among array elements deteriorates array performances and is usually avoided during synthesis and realization of the array antennas. Possiblities of utilizing the mutual coupling among the array elements to enhance array permonace are explored in this thesis. The analysis starts with the traditional filter theory where the mutual couplings among coupled-resonators with high-unloaded quality factors are used to obtain filtering properties. However, the same synthesis procedure is not directly applicable to an all-lossy coupled-resonator filtering antenna due to the difficulty in calculating and realizing the intended coupling coefficients. A modified synthesis procedure is developed in the first contributory chapter for the realization of a filtering array antenna consisting of all radiating resonators. In the following chapter, a filtering antenna is designed based on the developed synthesis approach. Moreover, rapid beam scanning, as opposed to traditional leaky-wave antennas, is achieved by exploring the phase-shifting property due to mutual coupling between the leaky resonators. In the next chapter, wideband antennas using tightly coupled slots are presented for radiation in the end-fire direction. Then, it is used for 360° azimuth-plane beam-scanning. The first example is with multiple-input multiple-output ports and the second one is with a single input and reconfigurable feed network for electronic beam scanning. Consistent gain and impedance matching over at least 24% bandwidth is achieved. In the fourth contributory chapter, a fixed frequency azimuth-plane beam-scanning antenna is designed using a mode-superposed coupled-mode patch antenna as the basic unit of a three-element electronically steerable parasitic array radiator. Mutual coupling is analyzed with the help of the Z-parameter matrix and is used to increase the antenna gain. In the final contributory chapter, two novel mode-coupled antennas with special characteristics of wide bandwidth and dual-band dual-polarization are presented. Theoretical analysis is followed by full wave electromagnetic simulations to obtain the physical diemsnions for each antenna presented in this thesis. Then, they are fabricated and the predicted results are validated by measurements.

Keywords: Coupled-mode antenna, coupled-resonator antenna, electronically steerable parasitic array radiator, filter antenna, fixed-frequency beam scanning antenna, frequency beam scanning antenna, mutual coupling, PIN diode series switch, wideband antenna.