PREFACE

The modern military radar system postulates the following operational and technological requirements:

- Instantaneous positioning of beam
- Rapid reaction time i.e. high data update rate
- Multi-mode operation
- Multi-target handling capability
- Less mechanical errors
- Higher reliability

These attractive features of radar system gave rise to the development of active antenna array. Even though active antenna arrays would conform to aforesaid appealing radar characteristics, their development necessitates that the antenna array should be of larger size to obtain better angular resolution as well as accuracy.

From another point of view, the inter-element spacing should be of the order of one-half wavelength ($\lambda/2$) at the maximum operating frequency for a maximum practical scan angle of 60^0 in order to avoid the appearance of grating lobes in antenna real space. Conforming to both conditions, viz. fine angular resolution as well as accuracy and avoidance of grating lobes could result in large number of antenna elements on the aperture of the array. Since each antenna element in the active array is associated with an individual source/receiver i.e. transmitting/receiving module (TRM), the cost of a fully dense array for large aperture becomes very high. Additionally, construction of antenna array is subject to mechanical and thermal limitations. Furthermore, since antenna elements on array aperture are positioned close to each other, the mutual coupling would be very dominant. This effect of mutual coupling is often technologically difficult to surmount and causes deleterious change in antenna array performance, particularly in the side lobe level and the scanning capability.

These limitations can be avoided successfully by reducing the number of antenna elements in the array configuration. If the reduction in the number of array elements is done with escorting increase in the inter-element spacing, the resulting antenna would be denoted as sparse array (also referred to as space tapered, random, non-uniform, aperiodic or arbitrary array). While the sparse configuration complies by removing antenna elements from a fully dense array, the antenna array is referred to as a thinned array.

The author has presented a brief description of thinned, non-uniformly spaced, and randomly spaced sparse antenna arrays. The problem formulations for the synthesis of these arrays of varying sizes and shapes (linear or planar) are considered in this thesis.

- Optimization of peak side lobe level (PSLL) at antenna boresight as well as pre-specified scan angles away from antenna boresight for uniformly excited antenna arrays
- Optimization of PSLL, half power beam width (HPBW) and gain of uniformly excited antenna arrays
- Reduction in PSLL by jointly optimizing antenna array configurations and amplitude excitation coefficients of antenna elements

To solve aforesaid problems, optimization methods based on genetic algorithm (GA) and particle swarm optimization (PSO) are developed in this research work. To examine the solution quality of these approaches in terms of design performance and to support novelty, different examples of linear and planar arrays have been numerically analysed. Results obtained through the proposed methods have been compared with those of similar configuration arrays reported in recent literature. The results of the investigations have shown that the proposed approaches outperformed the state-of-the-art synthesis methods. In addition, performance of proposed methods has been further validated through EM simulation and experimental study.

The author, from time to time, has reported the present research work part-wise at various IEEE conferences as well as in reputed journals, such as, *IEEE Antennas and Wireless Propagation Letters*, and *Journal of Electromagnetic Waves and Applications*.

The author would consider his limited contribution a success, if it is shown to be helpful in understanding as well as in the synthesis and realization of sparse antenna arrays for radar applications.