This book is devoted to design and development of recursive hyperspectral imaging algorithms for various applications. Part I includes three chapters that present the fundamental concepts and knowledge required for understanding the rest of the book: Chap. 2: “Simplex Volume Calculation,” Chap. 3: “Discrete-Time Kalman Filter for Hyperspectral Processing,” and Chap. 4: “Target-Specified Virtual Dimensionality for Hyperspectral Imagery.”

As for finding endmembers, the most widely used criterion for optimality is the simplex volume (SV). However, finding a correct and true SV was overlooked in earlier research since SV calculation is generally carried out by computing matrix determinants, and this approach has been considered straightforward. Unfortunately, it was shown in Li et al. (2015) and Li (2016) that such determinant-based SV calculation can only produce true SVs when the matrix to be calculated is square. For a nonsquare matrix using a matrix determinant to compute SVs will suffer a matrix singularity problem and may result in incorrect SVs. Chapter 2 investigates this issue. Furthermore, to explore the recursive structures of the designed algorithms, it is necessary to consider how algorithms are implemented. This leads to Chap. 3, in which discrete-time Kalman filtering is studied, where its concept will be used to derive the recursive hyperspectral image algorithms developed in this book. Finally, for unsupervised hyperspectral target detection algorithms, two key issues are of interest: (1) how many targets should be present in the data? and (2) how can these targets be found? Chapter 4 develops a unified theory for target-specified virtual dimensionality that can not only provide constructive algorithms for finding targets but also use these found targets to determine the number of targets that need to be generated by the algorithms.