1

INTRODUCTION

Hyperspectral imaging is a fast growing area in remote sensing. It expands and improves capability of multispectral image analysis. Two hyperspectral sensors currently in use and operated in airborne platform are 224-band AVIRIS (Airborne Visible/Infrared Imaging Spectrometer) and 210-band HYperspectral Digital Imagery Collection Experiment (HYDICE). They take advantage of hundreds of contiguous spectral channels to uncover materials that usually cannot be resolved by multispectral sensors. However, this advantage also comes with a price that many unknown signal sources may be also extracted by the sensors with no prior knowledge. In particular, these signal sources may include targets with size smaller than the ground sampling distance (GSD), which are generally embedded in a single pixel and cannot be identified by visual inspection. Their presence can be only measured by their spectral properties. Under these circumstances detection of such small targets cannot be accomplished by classical spatial-based image processing techniques. Instead, it must be carried out at subpixel level. Therefore, one of great challenges for hyperspectral imaging is subpixel detection, which is not treated in standard spatial-based image processing. After a target is detected, the next step is to classify detected targets according to their spatial or spectral properties. However, due to the high spectral resolution of a hyperspectral sensor and a large spatial coverage by GSD, it is often the case that more than one material substance will be present in a single pixel. In this case, a pixel may contain two or more material substances; thus it is no longer a pure pixel. To deal with such a pixel effectively, the pixel must be considered as a mixed pixel wherein several substances are present. This mixing activity further complicates image classification since traditional pure pixel-based classification techniques may not be applicable or effective even if they can be applied. Therefore, another challenging problem is to develop effective techniques for mixed pixel classification. This book is particularly written to aim at these two areas, subpixel detection and mixed pixel classification. Specifically, it is focused on problem solving techniques rather than theoretical treatment. Most techniques developed in this book are based on engineering perspectives and derived from aspects of statistical signal processing. They will be presented in a unifying framework so that readers can follow the flow, easily grasp the ideas and get hands-on algorithmic implementation.