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UNCONSTRAINED MIXED PIXEL CLASSIFICATION: LEAST-SQUARES SUBSPACE PROJECTION

The orthogonal subspace projection (OSP) for hyperspectral image classification was first reported in Harsanyi and Chang (1994) and has been successfully applied to hyperspectral data exploitation since then. Its ability in subpixel detection was also demonstrated in Chapter 3. As we recall (3.9), the OSP-derived detector was given by $\delta_{\text{OSP}}(\mathbf{r}) = \mathbf{d}^T P_{\text{U}}^{\perp}(\mathbf{r})$ with the scale constant $\kappa = 1$. In Chapter 6, we have seen that this scale constant κ was actually determined by the *a posteriori* information that was used to estimate the unknown abundance fractions. Since OSP assumed the complete knowledge of the target signature matrix **M** and did not estimate the abundance vector α, the scale constant κ was absent in $\delta_{\text{OSP}}(\mathbf{r})$. As long as the abundance fractions detected for α provide sufficient amounts for target detection, it did not matter if α was estimated accurately. That was why OSP worked effectively for the real hyperspectral data experiments in Harsanyi and Chang (1994). However, this may not be true in terms of abundance estimation. So, in this chapter, the OSP in Chapter 3 is revisited for mixed pixel classification. It is then extended by three unconstrained least-squares subspace projection approaches, called signature subspace projection (SSP), target subspace projection (TSP) and oblique subspace projection (OBSP) where the abundance fractions of target signatures are not known *a priori*, but are required to be estimated from the data. The three subspace projection methods use their estimated signature abundance fractions to achieve target classification in a mixed pixel. As a result, they can be viewed as *a posteriori* OSP as opposed to the OSP in Chapter 3, which can be thought of as *a priori* OSP. In order to evaluate these three approaches, a least-squares estimation error is cast as a signal detection problem in the framework of the Neyman-Pearson detection theory so that the detection performance can be measured by the receiver operating characteristics (ROC) analysis.