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Commentary

Spatial and Spectral Regularization in Unmixing of Spatial Images

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DESCRIPTION

The term remote sensing refers to the process of monitoring and detecting scene that has no or limited direct exploration without direct contact of it. It collects the physical characteristics of the scene by measuring radiance emitted or reflected by it. There are two types of sensing techniques and they correspond to active and passive. An active sensor has an external source of energy and captures the reflectance from the object while the passive sensor does not require the external energy source. Every material has the characteristics to react to each spectrum range differently. In remote sensing, multispectral sensors capture reflectance in 4 to 6 visible and infrared wavelength bands, while the hyperspectral sensors capture the reflectance in hundreds of contiguous bands in visible and near-infrared range, each with a narrow bandwidth.

Hence, they provide rich spectral details that make the signatures (reflectance) distinguishable. Such sensors are airborne to capture the selected area. To capture larger area, sensors can be mounted on the spaceborne platform. In the case of Hyper Spectral Images (HSI), the reflectance value at a pixel represents the average of the material's reflectance within the Instantaneous Field of View (IFOV). Due to this, the spatial resolution depends on IFOV. The spectral resolution of sensors is determined by the spectral width of each band and the number of spectral bands. Hyper spectral imaging emerges to identify new land cover classes remotely that are difficult to identify with lower spectral resolution images. Researchers successfully used hyper spectral images to identify minerals and map vegetation species, measure water vapour in the atmosphere, geological mapping and many more. Hyper spectral imaging is not only used in remote sensing but also explored for lab-scale applications such as food safety.

Many signal processing techniques are used or developed for hyper spectral imaging to better understand the hyperspectral data. Dimensionality reduction, target detection, change detection, classification and spectral unmixing are the most investigated techniques in the domain of hyperspectral imaging. Since the hyperspectral data has high spectral dimension, dimensionality reduction is often explored to reduce the same that aids in succeeding processing tasks. Target or anomaly detection techniques locate pixels in the scene with specific known or unknown spectral signature. The HSI data recorded for a particular scene at different acquisition times gives the temporal dimension to the HSI data which can be used to detect changes in specific region. Classification and spectral unmixing techniques are developed to identify and analyse the hyperspectral data at a pixel location.

In classification, the goal is to assign the class to each pixel, whereas spectral unmixing gives the fractions (abundances) of the materials (endmembers) present at the pixels. A spectral unmixing technique gives the sub-pixel information that helps in better analysis of the remotely sensed data. Hence, the researchers continue to explore the spectral unmixing area to improve the performance of the various remote sensing applications.

CONCLUSION

Hyperspectral data is recorded in hundreds of contiguous bands with very narrow bandwidth. HSI sensors are mounted on airborne or spaceborne craft to capture the reflected light energy of the sun from the scene (passive remote sensing). These sensors have a number of filter banks to capture images in the visible, near-infrared and shortwave infrared spectral bands. Hence, the HSI imaging is also referred to as the imaging spectroscopy, which combines both imaging and spectroscopy. Spectroscopy gives detail properties of the material by using the interaction between material and electromagnetic radiation as a function of the wavelength. One may note that, the term hyperspectral is used due to the large number of spectral bands for a single pixel location.

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