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Perspective

Advancements of Using Hyper Spectral Image Processing

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DESCRIPTION

Working with hyperspectral data requires organising and analysing data in high dimensional spaces. This greater dimensionality compared to multispectral images significantly increases the volume of data to be stored, transmitted and processed and introduces new challenges to conventional image processing techniques. Hyperspectral images exhibit a high degree of correlation between bands and hence lie on a lower-dimensional manifold within the high-dimensional data space. This leads to problems, e.g., when training a classifier it unnecessarily increases the required number of training samples. Working in high-dimensional data spaces leads to a number of technical difficulties, because the space will inevitably be very sparsely populated and distance measurements become meaningless. Dimensionality Reduction (DR) is the process of specifically identifying and eliminating redundancies of hyperspectral data, with the main goal of retaining as much spectral information as possible. DR can be especially useful for storage, transmission, classification and visualisation of hyper spectral remote sensing data.

There are many ways to perform dimensionality reduction and they can be grouped in supervised and unsupervised methods. The supervised methods include manual band selection, according to the application or rely on labelled samples to retain important features. On the other hand, unsupervised methods are only based on the statistics of the images. These targets are usually represented in only a few pixels and have small power compared to other signals in the image, and thus would be omitted as noise. In hyperspectral image processing pure pixels are those pixels that represent one single class/object type/material, as opposed to mixed pixels with spectral values that are a combination of two or more materials. Mixed pixels occur very frequently and are especially evident at the boundaries of objects. The rich spectral resolution can be used to seperate hyperspectral pixels and recover the information. Solving spectral unmixing requires the inversion of a mathematical model of radiative transfer that describes the transfer of energy, as photons interact with the materials in the scene. Linear mixing is a special case of spectral mixing, that occurs within the sensor due to its limited spatial resolution. The task of linear spectral unmixing is to define a set of endmembers (pure spectral signatures of macroscopic components) and the corresponding abundances that denote the fractional coverage.

CONCLUSION

When the Electromagnetic radiation interacts with more than one reflective material before reaching the sensor, this process is called non-linear mixing. Multilayer mixing occurs when the reflected signal has been scattered from multiple macroscopic surfaces/objects. This multiple reflection complicates the unmixing procedure as the finally recorded signal is an element-wise product of the individual endmembers. Non-linear mixing that occurs at a microscopic level is more challenging, as the materials are in close proximity and it depends on their composition. In non-linear unmixing the vast majority of methods require prior knowledge of the end members and fully unsupervised non-linear unmixing research is very limited.

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