Detecting Patterns in Hyperspectral Data by means of Unsupervised Algorithms and Band Selection

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Goals
Recent development of more sophisticated sensors enable the measurement of radiation in many more spectral intervals and at a higher spectral resolution than previously possible. Hyperspectral sensors gather enormous amounts of information. Yet, current algorithms are not able to extract a significant quantity of accurate features. New generations of algorithms are being developed for this complex data set in order to improve data analysis. Future research will be performed to use Physics-Based modeling in order to extract subsurface information to previously unattainable levels.

Significance
- New unsupervised classification algorithms are being developed to uncover patterns in this complex data. These methods integrated with Physics-Based modeling will enable us to extract hidden features embedded in a highly complicated medium.
- Precise analysis using hyperspectral data will permit the recognition of hidden objects. Possible targets are coral reefs mapping, underwater pollution, oil spills, and other contaminants.
- Multisensor fusion approaches are being used to reduce the redundant information by a Band Subset Selection algorithm.

Technical Approach
Different Unsupervised Classification schemes are being used in order to study hyperspectral data. These algorithms are different in the way they model the data. For example, ISODATA and c-means clustering algorithms model the data using first order statistics. They assume the variation in the data is due to noise. In contrast, c-means and covariances clustering algorithms use both first and second order statistics, and assume variation is an attribute of the object of interest. This results in an improved data modeling. These types of methods use only the spectral information acquired directly from the sensors, ignoring spatial information. Both contextual post-processing filters and the Unsupervised ECHO classifier integrate the spatial and the spectral information.
Current Status
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Plans and Project Evolution
- Different Statistical models have been applied to analyze the data. The use of first and second order statistics has improved the results. The integration of the spectral and the spatial information has produced better results in the detection of patterns.
- In the next three years Physics-Based modeling will be applied in the Hyperspectral Underwater Testbed.
- In 5-10 years we expect to develop a new method of hyperspectral data analysis for subsurface sensing that integrates Physics-Based modeling and Statistical Signal Processing.

References


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