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The Matlab hyperspectral image analysis toolbox

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The MATLAB Hyperspectral Image Analysis Toolbox

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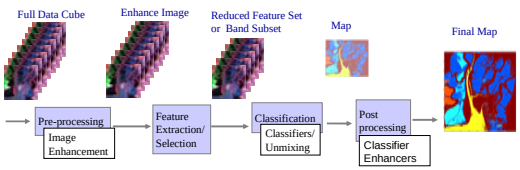
Introduction

The Hyperspectral Image Analysis Toolbox is currently being developed as an element of the CenSSIS Solutionware framework. The objective of the CenSSIS Solutionware team is to develop a set of catalogued tools and toolsets that will provide for the rapid construction of a range of subsurface algorithms and applications. Solutionware tools span toolboxes, visualization toolsets, database systems and application-specific software systems that have been developed in the Center. HIAT provides a computational environment where hyperspectral image processing algorithms developed from research done at UPRM Laboratory for Applied Remote Sensing and Image Processing (LARSIP) at UPRM are readily available to users in the environmental and biomedical communities. A HIAT deployment have been created in order to create an standard alone application.

Data Processing Scheme

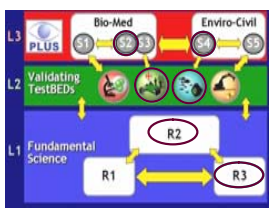


State of The Art

Hyperspectral Image analysis is supported by a variety of available software packages. The best known commercial product is the Environment for Visualizing Images (ENVI) [1] of Research Systems Inc., a ITT subsidiary. ENVI provides code extensibility through the Interactive Data Language (IDL), allowing the possibility for routine and features expandability. Among the educational non-commercial products, the best known is MultiSpec [2] developed at Purdue University by Dr. David Landgrebe and the Remote Sensing research group in Purdue's LARS. Multispec provides similar features to ENVI but does not provide extensibility.

HIAT Functionality

Input Image Formats	
• Matlab (*.mat) • JPEG • ASTER file format	• Remote Sensing (*.bip, *.bil, *.bsq) • TIFF
Image Enhancement	
• Oversampling Filter Single/Mirror Image Signal	• Reduce Rank Filter
Feature Extraction/Selection Algorithms	
• Principal Components Analysis • Singular Value Decomposition Band Subset Selection • Information Divergence Band Subset Selection	• Discriminant Analysis • Information Divergence Projection Pursuit • Optimized ID Projection Pursuit
Classifiers	
• Euclidean Distance • Fisher's Linear Discriminant • Angle Detection	• Mahalanobis Distance • Maximum Likelihood
Abundance Estimation	
• Non Negative Sum To One • Non Negative Sum Less than or Equal to One • Non Negative Least Square	• Unconstrained • Positive Constrained
Post-Processing Algorithms	
• ECHO 2x2 ECHO 4x4	• ECHO 3x3
Covariance Estimation using Regularization	
Online Documentation & Help	



CenSSIS Value Added

The Hyperspectral Image Analysis Toolbox provides support for CenSSIS Researchers and Students from R2C, S1, S3, and S4 using spectral imaging. The toolbox will be part of the tools that will be disseminated with the proposed Introduction to Subsurface Sensing and Imaging texbook and is a key component of the CenSSIS Solutionware.

Processing Example

Image acquired from Hyperion, a hyperspectral imager with 220 spectral bands (.4 to 2.5 µm) at 10 nm spectral resolution and a 30m spatial resolution. The area covers the area of Parguera in Lajas, Puerto Rico. This image has been collected to study the application of hyperspectral remote sensing to study coral reefs and other coastal characteristics of the area. In this example, a subset of the data of 169x255 pixels and 196 bands is used.

MATLAB HIAT

Gray Scale | Color Composite | True Color

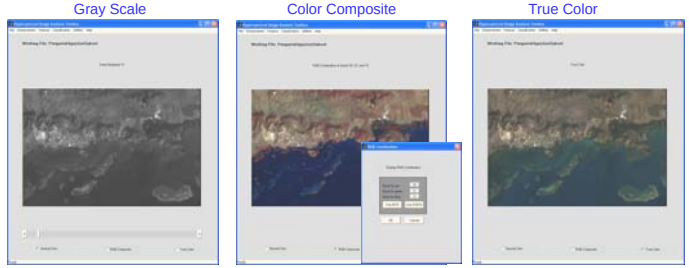
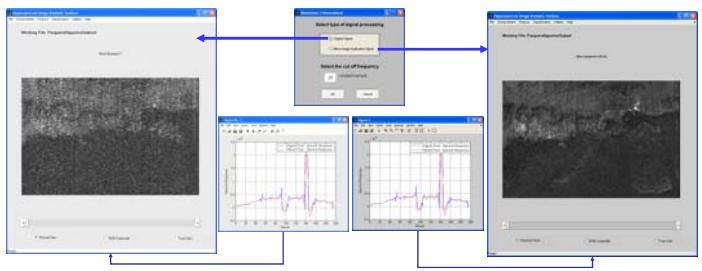


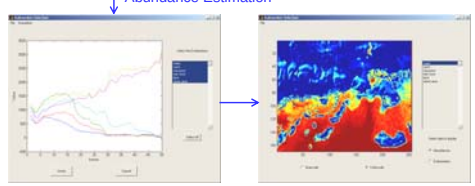
Image Enhancement



Classification and Unmixing Algorithms

Supervised & Unsupervised Classification

Abundance Estimation



Online Help & Documentation with Free Data Set

Downloading the Toolbox

Go to www.censsis.neu.edu

- Click in Software link
- Click in SSI Toolboxes
- Click under The Hyperspectral Toolbox
- Or Go To http://www.censsis.neu.edu/software/hyperspectral/Hyperspectoolbox.html

Future Work: Semi-Automated Processing Tool

HIAT Download Statistics

Year	Academy	Research Institutes, Agencies and Laboratories	Personal Use and Learning	**Total**
2005	115	55	59	**229**
2006	163	59	89	**311**
Total	**278**	**114**	**148**	**540**

HIAT Applications

biomedical imaging	land remote sensing	coastal remote sensing
vegetation	forensics	metallurgic study
biometric images	face recognition	remote sensing education

References

1. Research Systems Inc., ENVI, The environment for visualizing images, url: http://www.rsinc.com/envi/.
2. Landgrebe, D., Biehl, L., MultiSpec, image spectral analysis url: http://www.ece.purdue.edu/~biehl/MultiSpec/description.html.
3. S. Rosario-Torres, M. Vélez-Reyes, S.D. Hunt and L.O. Jiménez, "New Developments and Application of the UPRM MATLAB Hyperspectral Image Analysis Toolbox." In Proceedings of SPIE: Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XIII, Vol. 6565, May 2007.
4. Rosario S, et. Al. An Update on the Matlab hyperspectral image analysis toolbox. Proceedings of SPIE -- Volume 5806. Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XI, Sylvia S. Shen, Paul E. Lewis, Editors, June 2005, pp. 743-752

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