SARscape for ENVI

A Complete SAR Analysis Solution

Engineered for life
IDL and ENVI

A Foundation for SARscape

Engineered for life
IDL – The Data Analysis & Visualization Platform

- **Data Access:**
  IDL supports virtually every data format, type and size so you can focus on interpreting your data

- **Data Analysis:**
  IDL includes a rich library of proven math, statistics, image processing and signal processing routines

- **Data Visualization:**
  IDL is specifically designed for visualizing large and complex datasets
Data Analysis

- Array-oriented operations
- Built-in signal and image processing routines
- Extensive numerical analysis and statistics
- Wavelet analysis
- LAPACK Library
- IDL Analyst: IMSL Library
- Multi-threaded processing
- User-defined routines
ENVI – Product Overview

- Windows (2000 & XP), Linux, Mac OS X, HP-UX, AIX, IRIX, Solaris
- Extensive Image and Vector Format Support
- Certified NITF Read/Write
- Calibration Utilities
- FLAASH Atmospheric Correction (MODTRAN)
- Image Enhancement and Statistics
ENVI – Product Overview

- Regions of Interest Utilities
- Image Transforms and Filtering
- Change Detection Analysis
- Automatic Image Registration and Orthorectification
- Mosaicking
- Map Composition
ENVI – Summary

• ENVI is a complete image processing and remote sensing software package
• Leader in multispectral and hyperspectral analysis
• Intuitive GUI makes ENVI easy to learn and use
• ITT’s Global Services Group are experts at using IDL to extend and customize ENVI
SARscape

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What is SARscape?

- A modular set of functions dedicated to the generation of products derived from spaceborne Synthetic Aperture Radar (including JERS-1, ERS-1/2, Radarsat-1, ENVISAT/ASAR and ALOS/PALSAR)
- Developed by sarmap, a Swiss company
- An ENVI plug-in written in C++
- Currently comprised of 6 modules, 2 base modules and 4 extensions, with more on the way
- Very robust variety of SAR tools that are complimented by the power of ENVI and IDL
SARscape in ENVI

- SARscape appears as a main menu item in ENVI with all of the modules appearing as items under the main SARscape menu.
Current SARscape Modules

**Basic**
- includes a set of processing steps for the generation of SAR-based products
- complemented by multi-purpose tools which include a wide range of functions - from image visualisation, to Digital Elevation Model import and interpolation, to cartographic and geodetic transforms

**Focusing**
- extends focusing capabilities to RADARSAT-1 (Fine Beam and Standard Beam), ENVISAT ASAR (Alternating Polarisation, Image, and Wide Swath), and ALOS PALSAR (Fine Beam, ScanSAR, Polarimetric) data

**Gamma & Gaussian Filter Module**
- an extension of the Basic module
- includes a whole family of SAR specific filters
- algorithms are based on Gamma/Gaussian-distributed scene models
- particularly efficient at reducing speckle, while preserving the radar reflectivity, the textural properties and the spatial resolution, especially in strongly textured SAR images
Current SARscape Modules

**Interferometry (InSAR/DInSAR)**
- Interferometric SAR (or 2-pass interferometry, InSAR) and Differential Interferometric SAR (or n-pass interferometry, DInSAR) module
- dedicated to the generation of Digital Elevation Model, Coherence, and Land Displacement maps

**ScanSAR Interferometry (InSAR/DInSAR)**
- developed by aresys based on an original algorithm of Politecnico di Bari (POLIBA)
- extends the Interferometry module to ScanSAR mode
- offers some brand-new low resolution products, such as Coherence, Interferogram, and Land Displacement maps

**SAR Polarimetry & Polarimetric Interferometry (PolSAR & PollInSAR)**
- supports the processing of polarimetric and polarimetric interferometric SAR data
Upcoming Modules

Persistent Scatterers (PS)
- developed in collaboration with ARESYS
- enables the identification of mm-scale displacements of individual features (e.g. buildings) on the ground
- This module will be released in Q3 2007

Ship/Wave/Oil Spill Detection
- Module scheduled for release in Q4 2007
SARscape Modules – What works with what

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ITT
Visual Information Solutions
Supported SAR Systems

Current operational systems

ERS-1/2 1991
RADARSAT-1 1996
ENVISAT 2002
ALOS 2006
Supported SAR Systems

Planned for launch:

- RADARSAT-2
  - 2007

- RISAT
  - 2007

- TerraSAR X
  - 2007
Additional Info:

• sarmap will work with a customer to develop tools necessary for their particular products

• they will modify the source code to add in a new data format for a proprietary sensor (this will depend upon how much info can be given to sarmap about the data format and specifics)

• They will also entertain the idea of opening up the source code if some of the parameters cannot be shared so that the customer can do the work in-house (for classified projects)
Basic Module Examples

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Resource Management

The example shows a change detection map derived from ERS-2 SAR data acquired in 1996, 1998 and 1999 in an area of Sri Lanka.

The map shows three classes: Stable water bodies (blue), Shrimp farms as observed on April 18th 1996 (red), and their expansion as imaged on October 16th 1998 (pink).
Agricultural Planning and Management

Rice mapping

Image courtesy of IRRI
ERS $\sigma^0$ time series image

ERS-2 desc, 05-May-96
ERS-2 desc, 09-Jun-96
ERS-2 desc, 14-Jul-96
Rice map using $\sigma^o$ time series

- Single Crop Rice
- Double Crop Rice Irrigated
- Mixed Double Crop Rice
- Double Crop Rice 1
- Double Crop Rice 2
- Urban areas, roads and uncultivated areas
Rice map overlaid with GIS data
Monitoring rice transplanting in the Philippines - Year 2004 Radarsat-1 & ENVISAT ASAR AP data
Disaster Response

Flood extent mapping

Image courtesy of FEMA, USA
Flood Mapping in Bangladesh, 2004

28 July 2004 (R,G) & 19 May 2004 (B)  
25 July 2004 (R,G) & 23 Mar 2003 (B)

Envisat ASAR Wide Swath data

Bangladesh
Flood Mapping in Bangladesh, 2004

GIS representation of the flood extent

Bangladesh
Environmental Applications

Ship captured during a seepage action

Oil slick imaged by ERS-1 SAR
SARscape Applications

- Forest Mapping
- Flood Mapping
- Oil Slick Monitoring
- Agriculture
- Rice Mapping
- Landslides/Subsidence
- Land Cover Mapping
- DEM Generation

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Interferometry Example
Interferometry Workflow
From Single Look Complex (SLC) Data to a DEM:

Input: Master and Slave SAR SLC Images

Output: DEM
Baseline Estimation

Estimation of the image-pair baseline parameters

Input Master file: C:\data_projects\SARscape\training_courses\practical_sessions\LasVegas_InSAR\7_11_02_slc
Input Slave file: C:\data_projects\SARscape\training_courses\practical_sessions\LasVegas_InSAR\16_01_03_slc

Normal Baseline (m) = 106.296
Critical Baseline (m) = 1417.917
2 PI Ambiguity height (m) = 110.792
Range Shift (pixels) = 0.806
Azimuth Shift (pixels) = 112.084
Doppler Centroid diff. = -44.635 Critical = 1694.995

Est. baseline file: C:\data_projects\SARscape\training_courses\practical_sessions\LasVegas_InSAR\baseline_est
Interferogram Generation – Raw Interferogram

Interferogram_int
Multi-looked Master and Slave Generation

Looks: 4 azimuth / 1 range
Ground-Resolution: ~ 15 x 15 meters
Interferogram Flattening With Ellipsoid

![Ellipsoidal Interferogram Flattening interface](image1)

Interferogram_dint
Extraction of a Reference DEM

GTOPO DEM_dem
(resampled to 15 m)
Adaptive Filter and Coherence Estimation

Interferogram_fint

coherence_cc
Phase Unwrapping

![Phase Unwrapping Interface]

- Input Interferogram file
- Input Coherence file
- Output Phase file
- Coherence threshold: 0.25

Interferogram_upha
Phase Editing

![Phase Edit Start](image)

- **Input file**
- **Output file**
- **Selection file**

- **Overwrite file**

- **Start**
- **Cancel**
- **Help**
Baseline Fit

<table>
<thead>
<tr>
<th>Master file</th>
<th>Slave file</th>
<th>Synthetic phase</th>
<th>Phase file</th>
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In case topographic maps were available, GCP values (coordinates and heights) must be entered manually.

In this example (use of a reference DEM in slant range), values are automatically read.
Baseline Fit

Reflattened Interferogram_dint
Phase to Map Conversion

![Phase to Map conversion](image)

- **Phase file**
- **Master orbit file**
- **Slave orbit file**
- **Coherence file**
- **Synthetic Interferogram file**
- **Output Root Name**

**Output Cartographic System**
- **State**: UTM-GLOBAL
- **Hemisphere**: NORTH
- **Projection**: UTM
- **Zone**: 1
- **Ellipsoid**: WGS84

**Datum Shift Parameters**

- **Coherence threshold**: 0.25000
- **Grid size**: 25.0000
- **Interpolation Window size**: 0
- **Mean Window size**: 0

[Buttons: Start, Store Batch, Cancel, Help]
Final DEM
ENVI Fx

Rapid Feature Extraction

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The new ENVI Feature Extraction Module provides an easy to use workflow for extracting important information from high resolution Panchromatic and Multispectral data.

- **Vehicles**
  - Airplanes, Tanks, Cars, Ships
- **Buildings**
  - Building Outlines, Residential Rooftops
- **Transportation**
  - Roads, Bridges, Airports, Harbors
- **Natural Features**
  - Rivers, Lakes, Forest, Fields
The ENVI Feature Extraction Module is:

Easy to Use - Fast & Interactive - Accurate - Repeatable

• Three steps get you to the answer you need:
  • Segment
  • Merge
  • Classify

• Less ramp-up time and fewer clicks means people with all skill levels can obtain results quickly.