Automated Registration of Imagery and Raster Data in ArcMap

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  Hybrid Powered Auto-Registration Engine

> Registration of E/O Satellite Images

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Motivation

**Image Registration for:**

- Georeferencing
- Change detection
- Data fusion
- Mosaicing
- Generation of Digital Elevation Models
- 3-D modelling

**Requirements:**

- High accuracy
- Automatisation

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Automated Generation of Tie Points

- It combines all the available spatial reference information with a number of registration approaches.

- Generation of tie points:
  - [General] Cross Correlation
  - [Cross-Modality] Mutual Information

- Filtering of tie points:
  - Geometric models:
    - Fitting Global Transform
    - Frame Central Projection
    - Pushbroom Sensor with RPC
  - Transformations:
    - First Order Polynomial
    - RST
Image Registration Workflow

1. File selection
2. Selecting HyPARE algorithms
3. Parameter settings
4. Tie points

HyPARE Registration Engine

Review tie points

Manual editing?

Required accuracy?

Quality control

Share results

Registered image / orthophoto

Warping & resampling

Airborne and spaceborne imagery, DEM

Thursday, Oct 24, 2013
Registration of Images
Obtained from Different
Off-Nadir Viewing Angles

- Tokyo, Japan
- Base: IKONOS
  Azimuth 224.37°
- Warp: IKONOS
  Azimuth 144.36°
- Method:
  Cross Correlation
- Geometric model:
  Frame Central Projection
- 73 tie points

IKONOS multi-spectral mono image of Tokyo.
IKONOS images are kindly provided by Japan Space Imaging (JSI) Corporation.
Registration of Images with RPC Information and DEM

- Madagascar
- Base: GLS2000
- Warp: RapidEye
- DHM: SRTM
- Method:
  - Cross Correlation
- Geometric model:
  - Fitting Global Transform
- 4 seed points
- 72 tie points

Includes material © (2012) RapidEye S.à r.l.
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USGS 2013, Global Land Survey, 2000,
Landsat ETM+, 15m scene p158r073_7dx20010929,
USGS, Sioux Falls, South Dakota.
Registration of Images with RPC Information and DEM

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USGS 2013, Global Land Survey, 2000, Landsat ETM+, 15m scene p158r073_7dx20010929, USGS, Sioux Falls, South Dakota.
Registration of Data from the Corona Missions

- Magarsos, Cilicia, Turkey
- Base: Quickbird Pan (2003)
- Warp: Corona KH-4b (1968)
- Method: Cross Correlation
- Geometric model: Fitting Global Transform
- 5 seed points
- 25 tie points

Quickbird imagery, 13.03.2003 © DigitalGlobe, Inc. All rights reserved.
Corona imagery, mission KH4b, 20.11.1968 (USGS-products, available from the U.S. Geol. Survey)
Registration of Aerial Photos

Registration of Image Sequences from UAV Surveying Flights

- Waterloo, Canada
- Georeferenced
- Method: Cross Correlation
- Geometric Model: Frame Central Projection
- 112 tie points

Aeryon Photo3S™ camera on an Aeryon Scout micro-UAV™.
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Registration of Historic Aerial Photos to Topographic Maps

> Hannover, Germany
> Base: TK 1:25,000
> Warp: aerial photo
> Method: Mutual Information
> Geometric model: Frame Central Projection
> 3 seed points
> 29 tie points

Data by courtesy of LGLN Hannover.
(Landesamt für Geoinformation und Landentwicklung Niedersachsen)
Registration of Historic Aerial Photos

- Hannover, Germany
- Base: aerial photo
- Warp: aerial photo
- Method: Cross Correlation
- Geometric model: Frame Central Projection
- 3 seed points
- 79 tie points

Data by courtesy of LGLN Hannover.
(Landesamt für Geoinformation und Landentwicklung Niedersachsen)
Registration of Aerial Photos to Topographic Maps

- Frankfurt, Germany
- Base: TK 1:50.000
- Warp: aerial photo
- Method: Mutual Information
- Geometric model: Frame Central Projection
- 5 seed points
- 31 tie points

Data by courtesy of HLBG Wiesbaden.
(Hessisches Landesamt für Bodenmanagement und Geoinformation)
Multi-Sensor Image Registration

Registration of Optical Data to SAR-Data

> Rome, Italy
> Base: TerraSAR-X
  StripMap Mode
> Warp: SPOT-5
> Method: Mutual Information
> Geometric model: Fitting Global Transform
> 68 tie points
Multi-Sensor Image Registration

Registration of Optical Data to High-Resolution SAR-Data

> Hannover, Germany

> Warp: Pléiades-1a
  - GSD 0.5 m
  - Primary product (L1A)
  - Sept. 04, 2012

> Base: TerraSAR-X
  - SpotLight Mode
  - GSD 1.25 m
  - GEC product (L1B)
  - Sept. 20, 2012
Multi-Sensor Image Registration

Registration of Optical Data to High-Resolution SAR-Data

- Hannover, Germany
- Base: TerraSAR-X
  - SpotLight Mode
- Warp: Pléiades-1a
- Method:
  - Mutual Information
- Geometric model:
  - Fitting Global Transform
- 3 seed points
- 53 tie points

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Motivation

Is Multi-Sensor Image Registration Ready for Operational Use in ArcMap?
Implementation in ArcMap

**Software Products Used**

- ArcGIS 10.x
- ENVI 5.0
- ENVI SARscape 5.0
- IDL 8.2

Allows users to analyze imagery and easily share data between ArcGIS, ENVI, and ENVI SARscape.
Implementation in ArcMap

Combined Workflow for SAR Processing & HyPARE Image Registration

**SAR Processing**

1. SAR Raw Data
2. Data Focusing
3. SAR SLC Data
4. Multi-Looking
5. SAR Intensity Data
6. Despeckle Filtering
7. Geocoding & Calibration

**HyPARE Image Registration**

- Satellite Image
- Digital Elevation Model

**Step 3**

Registered Image / Orthophoto

EXELIS

Visual Information Solutions
Implementation in ArcMap

SAR Processing

Step 1

Step 2
Multi-Source Image Registration

Step 1 & 2

Step 3
Implementation in ArcMap

Step 1: Filtering

> **Gamma Distribution-Entropy Maximum A Posteriori (Gamma DE-MAP) Filter**

```python
import sarscapepy, arcpy

inRasterName = arcpy.GetParameterAsText(0)
outRasterName = arcpy.GetParameterAsText(1)
eq_looks = arcpy.GetParameterAsText(2)
win_size = arcpy.GetParameterAsText(3)

toolname = 'single_image_filter'
sarscapepy.RunTool(toolname, inRasterName, outRasterName, eq_looks, win_size,
                    Library=r'C:\n\DATA\TECHNICAL_RESOURCE_CENTER\1_ENVI\Demos\Registration

PRO single_image_filter, inRasterName, outRasterName, eq_looks, win_size

COMPILE_OPT id12
ENVI_CHECK_SAVE, /TRANSFORM
ENVI_Batch_Init, /NO_STATUS_WINDOW

SARSCAPE_READ_DEFAULT_BASE, def_par
oB = OBJ_NEW('SARscapeBatch', MODULE='DETECTEDSINGAMMADEMAP')
oB->SetParam, 'input_file_list', [inRasterName]
oB->SetParam, 'output_file_list', [outRasterName]
oB->SetParam, 'eq_looks', STROPCOMPRESS(STRING(eq_looks), /REMOVE_ALL)
oB->SetParam, 'win_size', STROPCOMPRESS(STRING(win_size), /REMOVE_ALL)

ok = oB->VERIFYPARAMS()
ok = oB->EXECUTE()
```
Implementation in ArcMap

Step 2: Geocoding & Radiometric Calibration

> Using the corresponding ENVI SARscape function from within the ArcGIS Toolbox.
Implementation in ArcMap

Step 3: HyPARE Image Registration

> The release of the ENVI/IDL API for HyPARE image registration in batch mode is planned for 2014.
HyPARE (Hybrid Powered Auto-Registration Engine)

> Combines all the available spatial reference information with a number of registration approaches.
> Improves the reliability, accuracy, performance and automation of the tie point registration and the subsequent image registration.
> The robustness of the algorithm allows the registration of images obtained from different viewing angles, in different time and seasons, and by sensors with different modalities.

> Future Developments
> Register images to LiDAR point clouds and to GIS vector layers.
Conclusions

Multi-Sensor Image Registration Will Be Ready for Operational Use in ArcMap!

> This approach enables us to exploit the HyPARE technology in ArcMap Desktop.

> Allows to process SAR data in ArcMap using the full functionality of ENVI SARscape.

> With ENVI for ArcGIS multi-sensor image registration can be provided within any ArcGIS environment whether deployed at the enterprise level, or online.
Questions & Discussion

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