EXELIS

Visual Information Solutions

Automated Registration of Imagery and Raster Data in ArcMap

ESRI EMEA UC 2013, Munich
Session Environmental and Forestry Management
October 24, 2013

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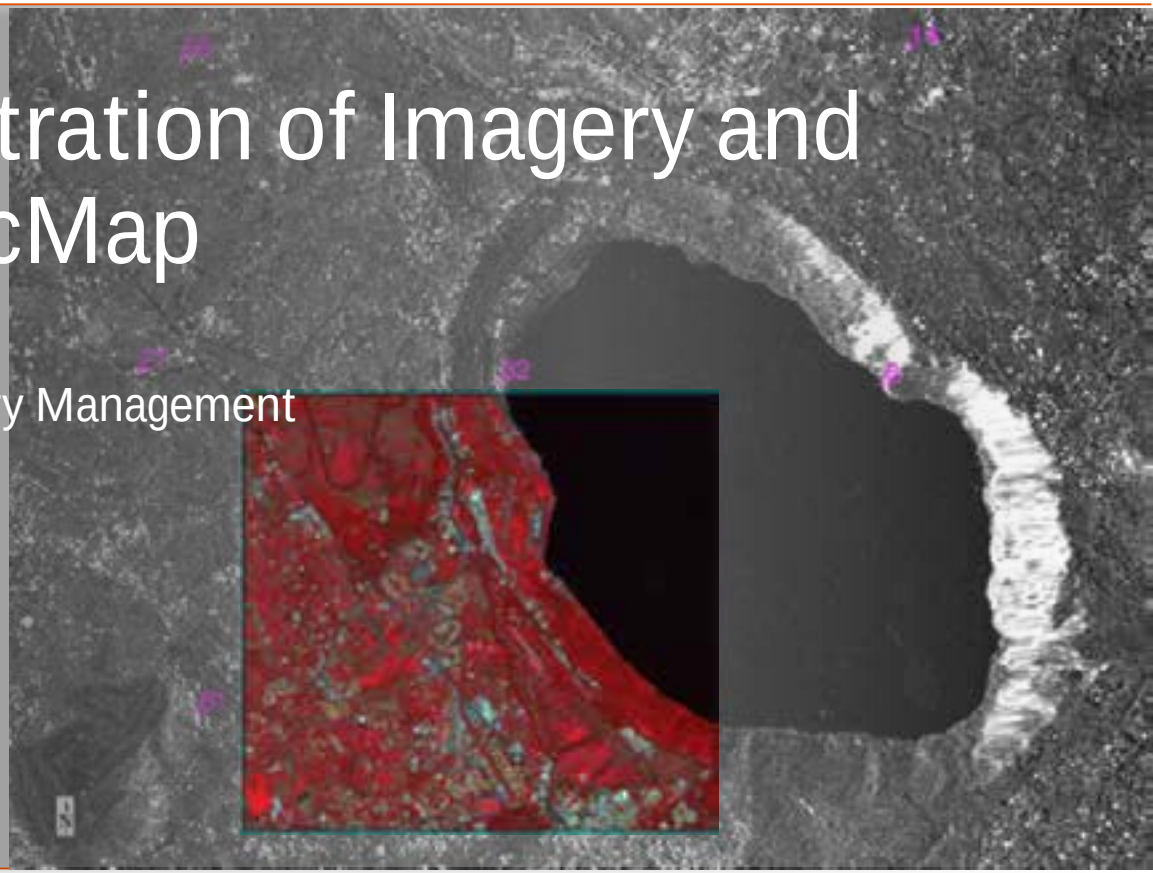

Contents

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- HyPARE
  Hybrid Powered Auto-Registration Engine
- Registration of E/O Satellite Images
- Registration of Aerial Photos
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- Summary & Outlook

Motivation

Image Registration for:

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

Requirements:

> High accuracy
> Automatisation

HyPARE (Hybrid Powered Auto-Registration Engine)

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

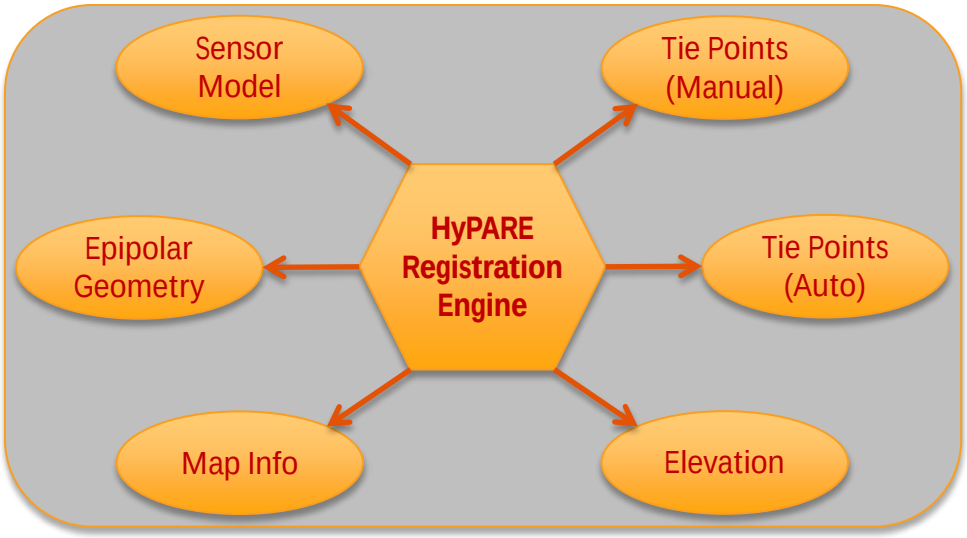
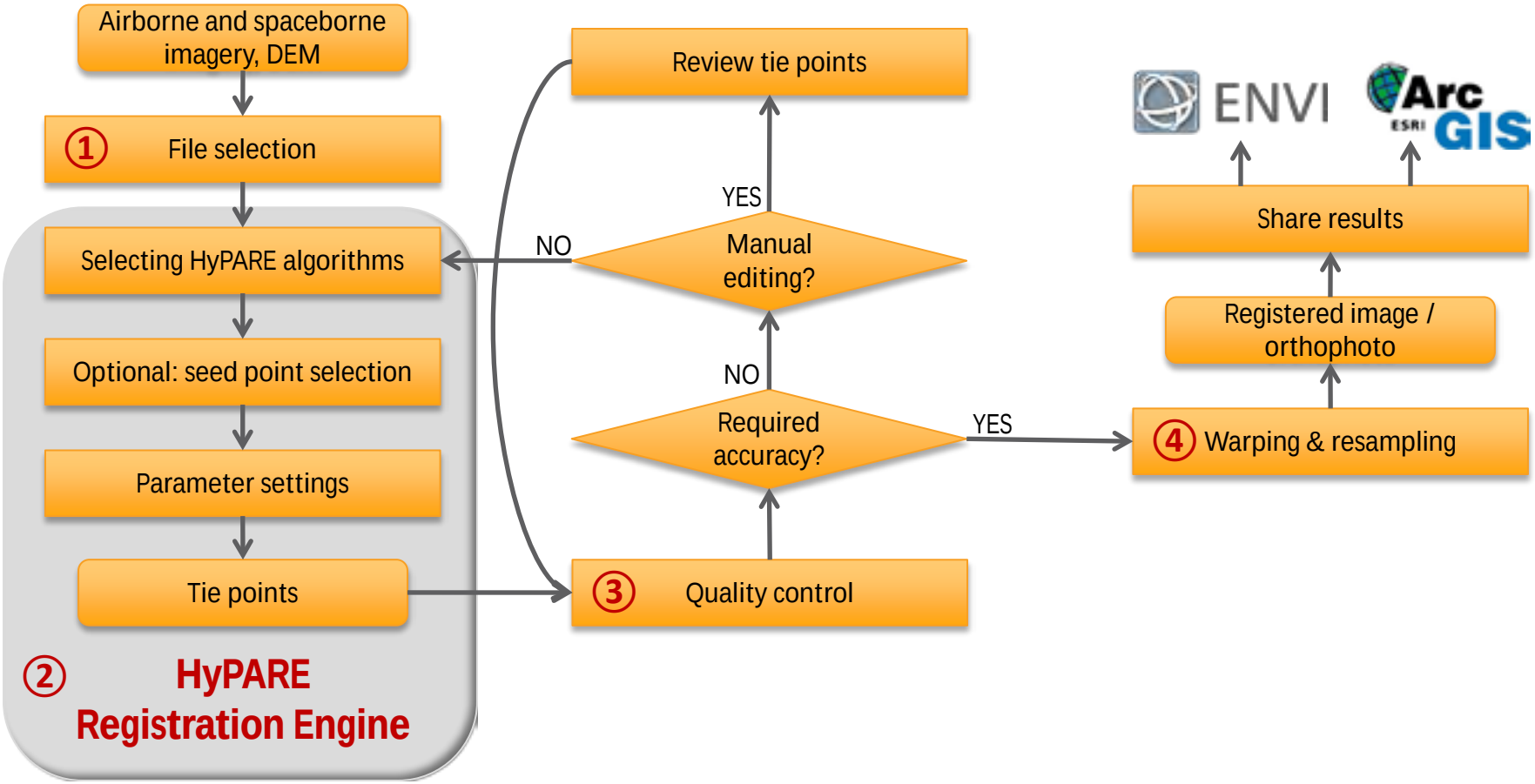


Image Registration Workflow



Registration of E/O Satellite Images

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.

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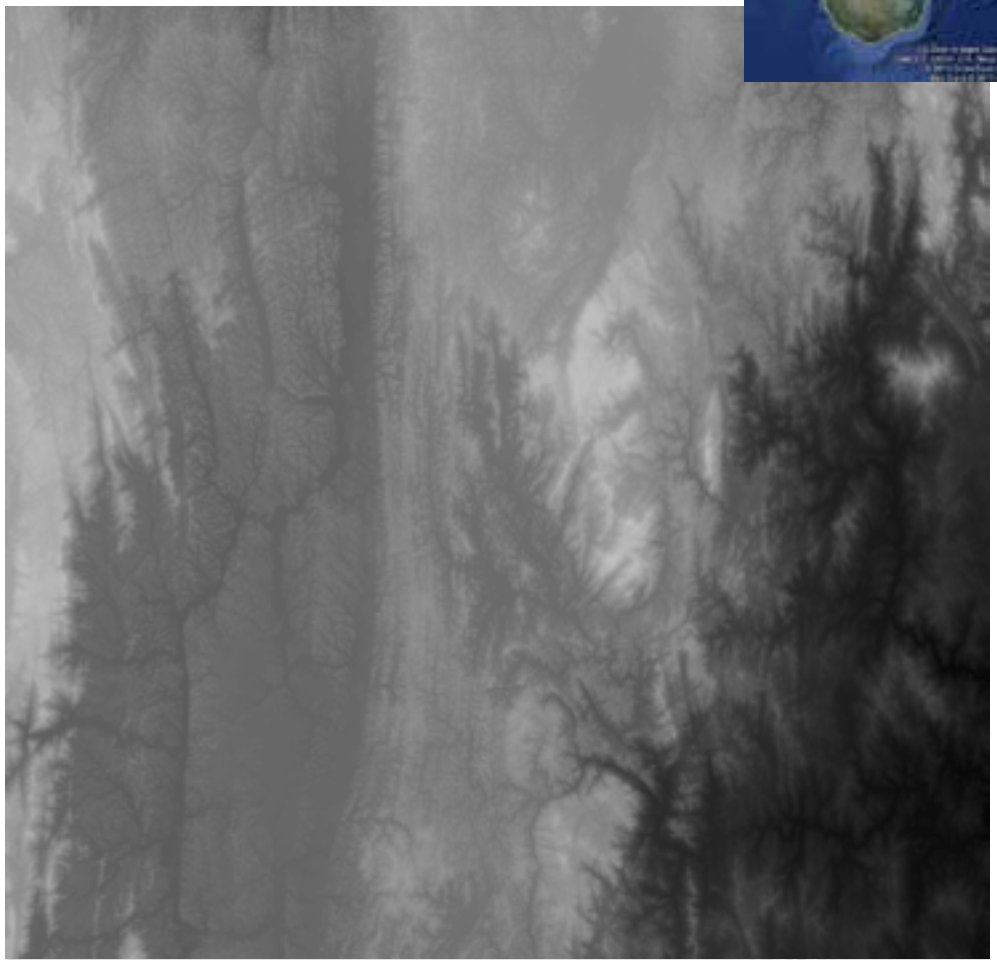
Registration of E/O Satellite Images

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



USGS 2013, Global Land Survey, 2000,
Landsat ETM+, 15m scene p158r073_7dx20010929,
USGS, Sioux Falls, South Dakota.

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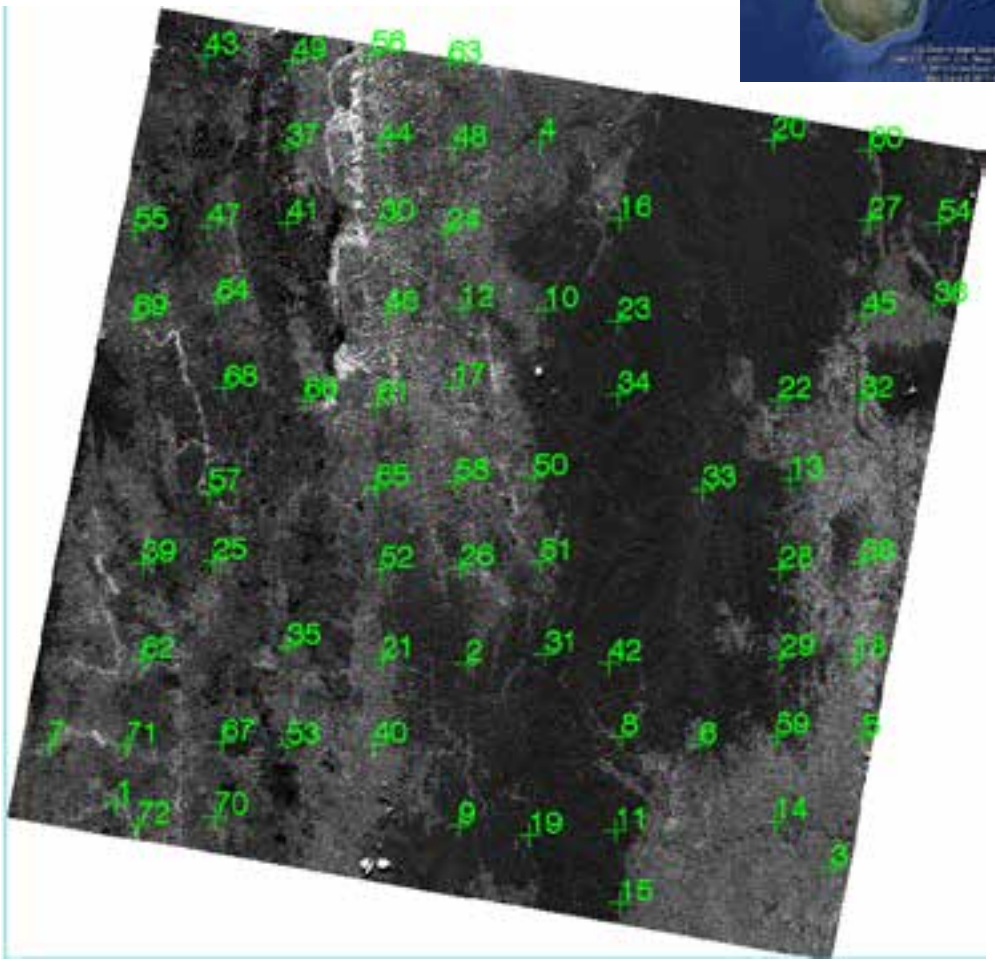

USGS 2013, Global Land Survey, 2000,
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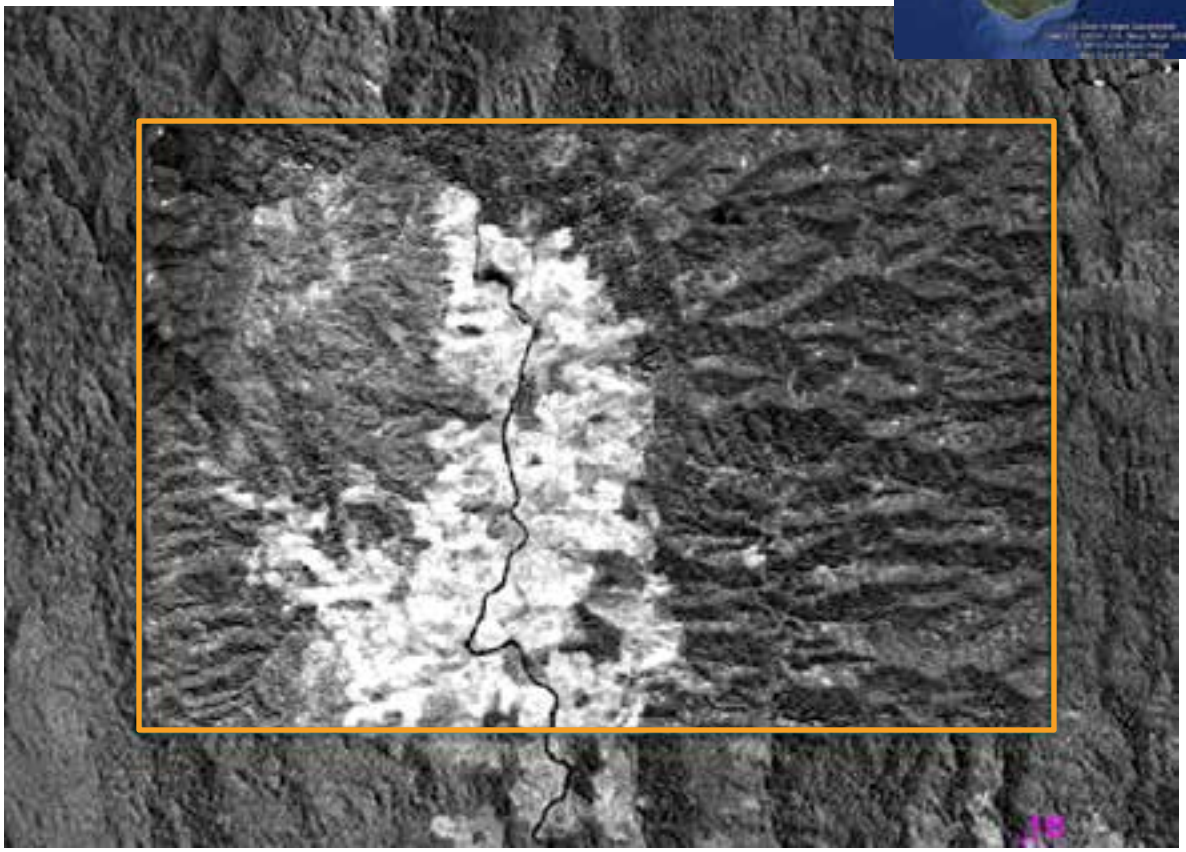

USGS 2013, Global Land Survey, 2000,
Landsat ETM+, 15m scene p158r073_7dx20010929,
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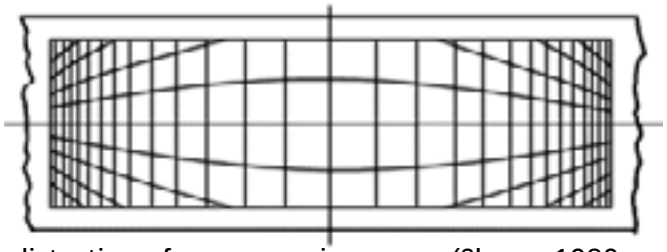
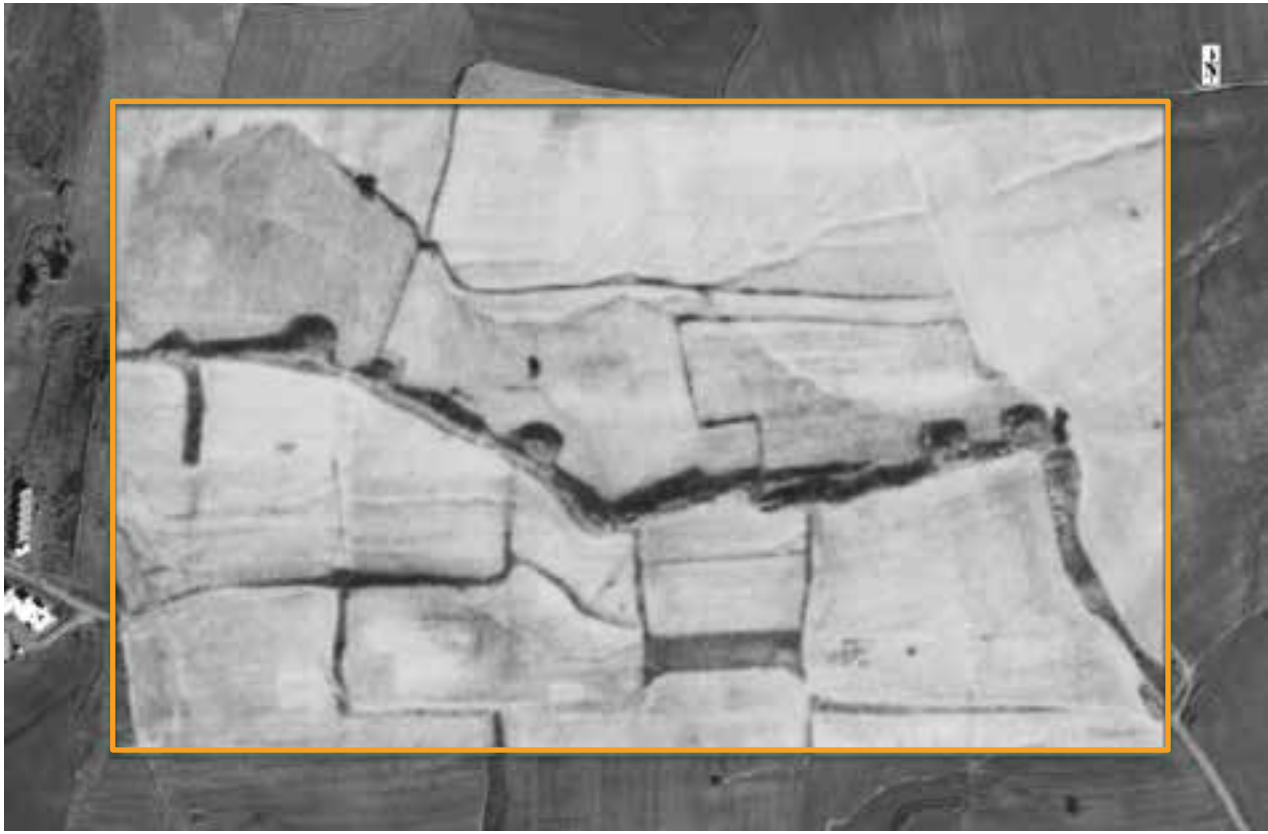
Registration of E/O Satellite Images



Film distortion of a panoramic camera (Slama, 1980, p. 201).

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)

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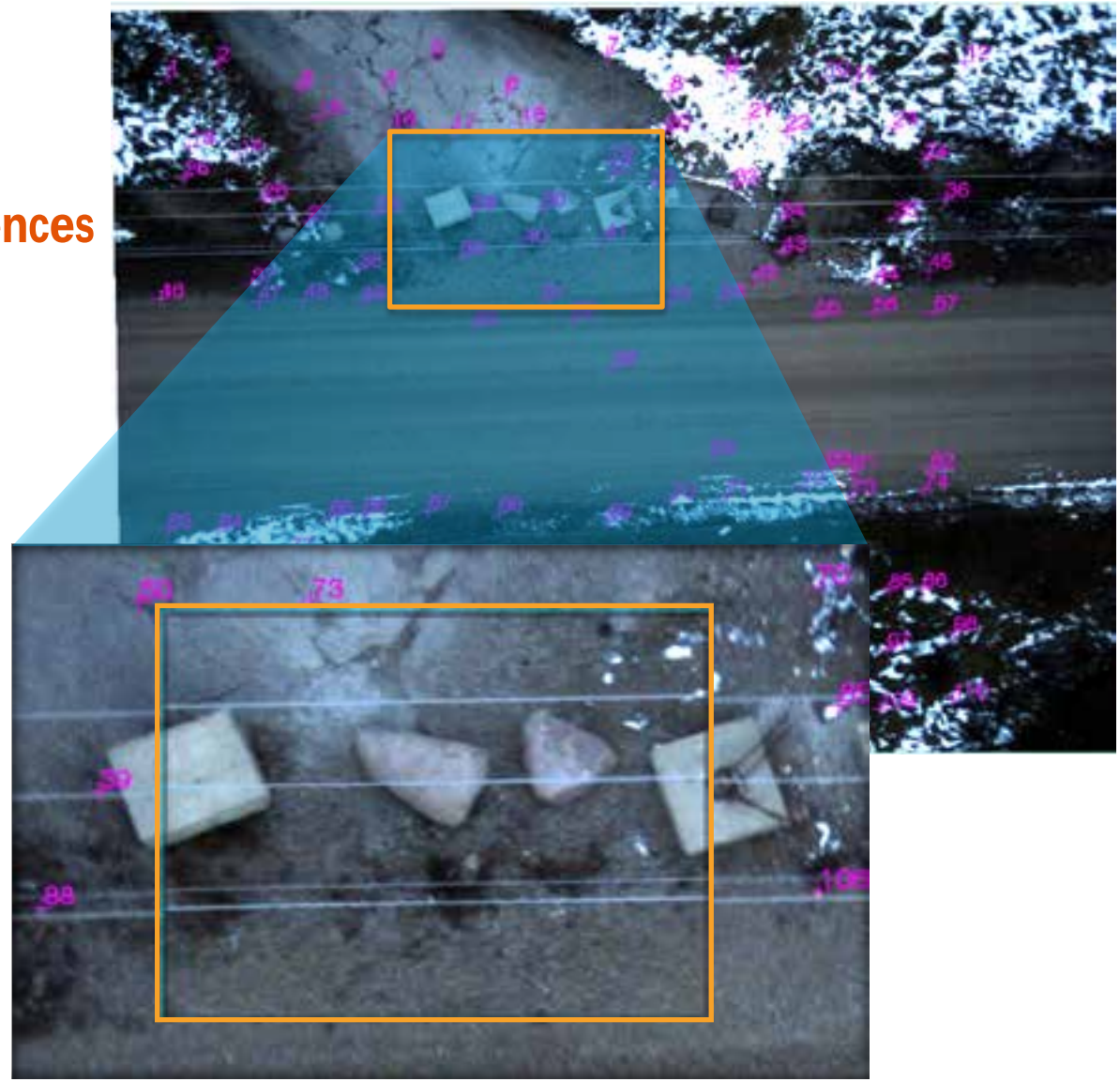
Registration of Aerial Photos

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™.

Registration of Aerial Photos

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 Aerial Photos

Registration of Historic Aerial Photos

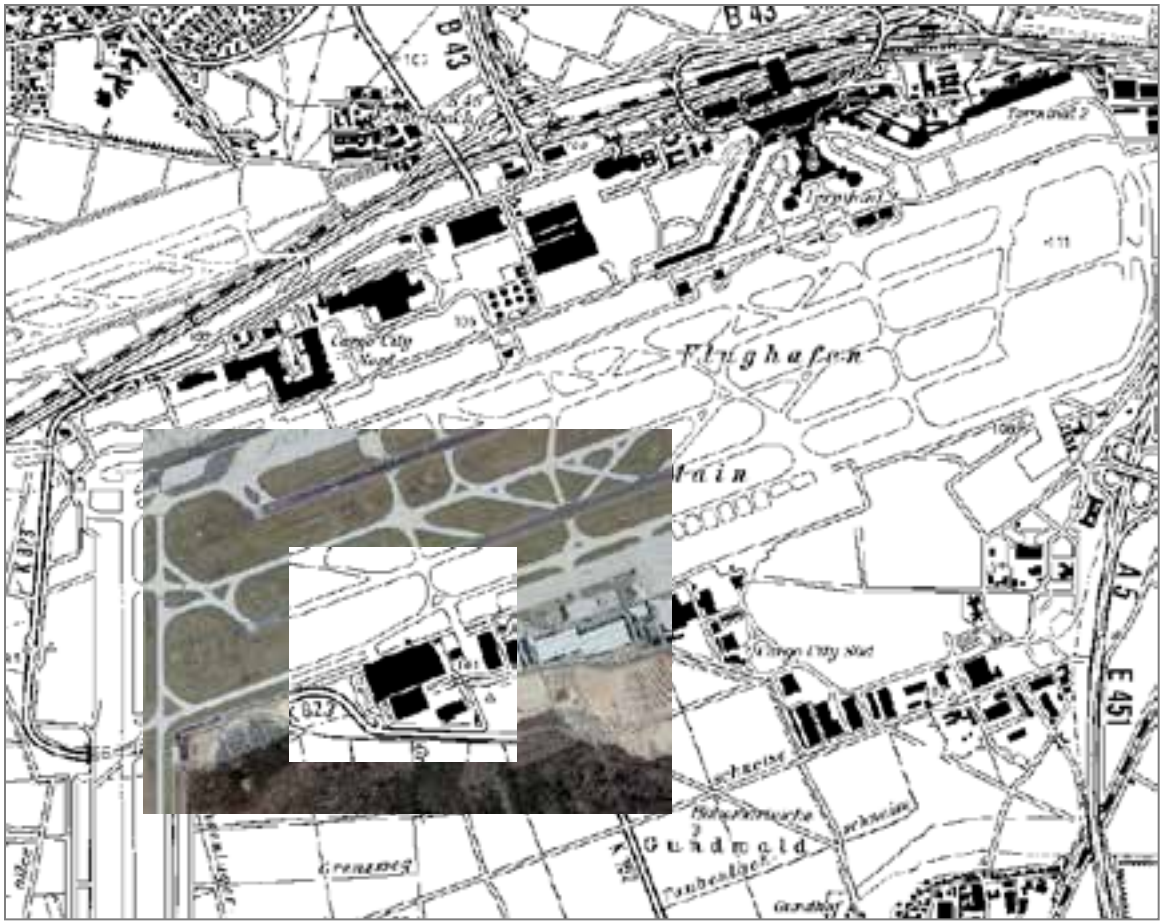
- Hannover, Germany
- Base: aerial photo
- Warp: aerial photo
- Method:
  Cross Correlation
- Geometric model:
  Frame Central Projection
- 3 seed points
- 79 tie points

Data by courtesy of LGLN Hannover.
(Landesamt für Geoinformation und Landentwicklung Niedersachsen)

Registration of Aerial Photos

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)

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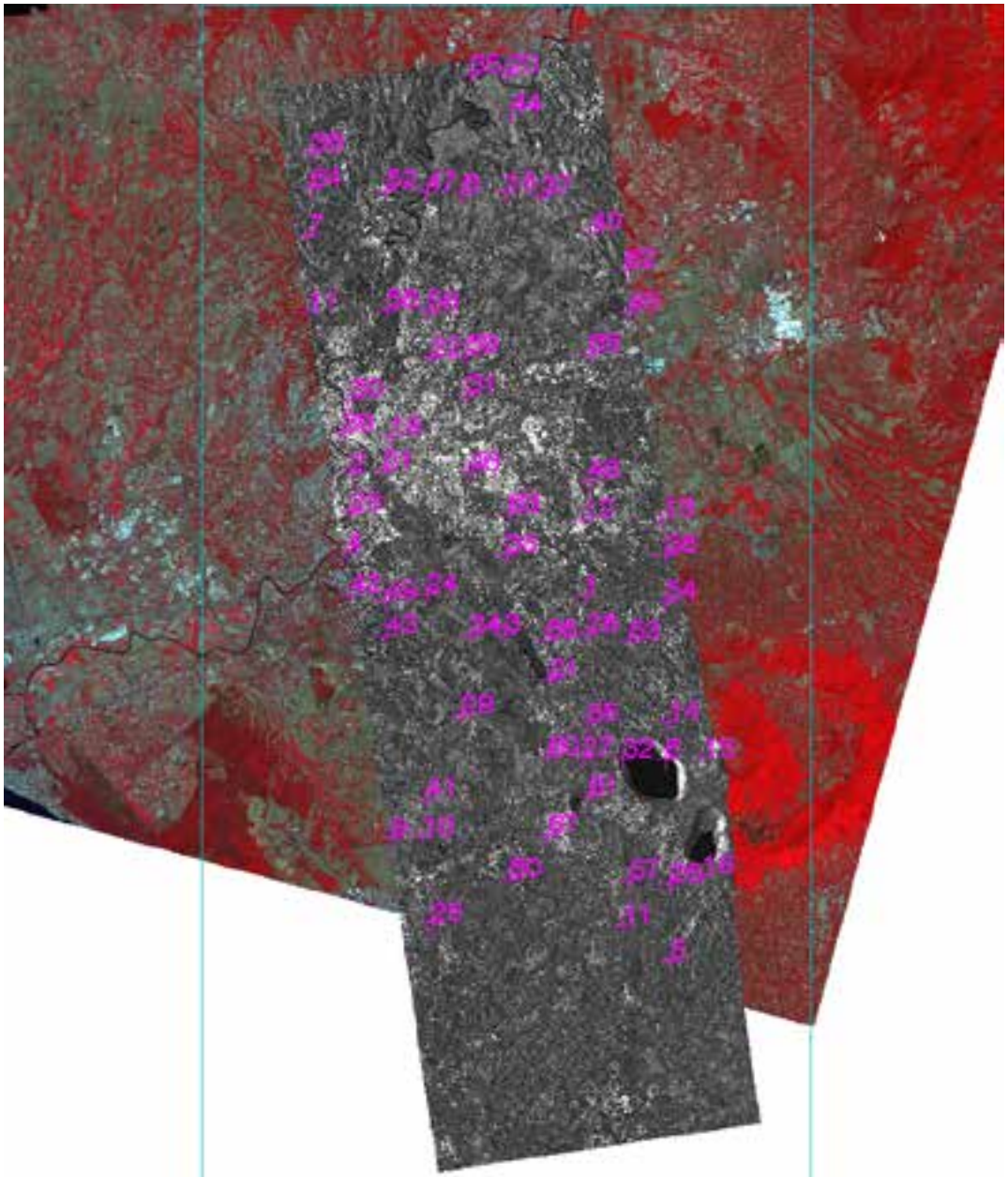
Multi-Sensor Image Registration

Registration of Optical Data to SAR-Data

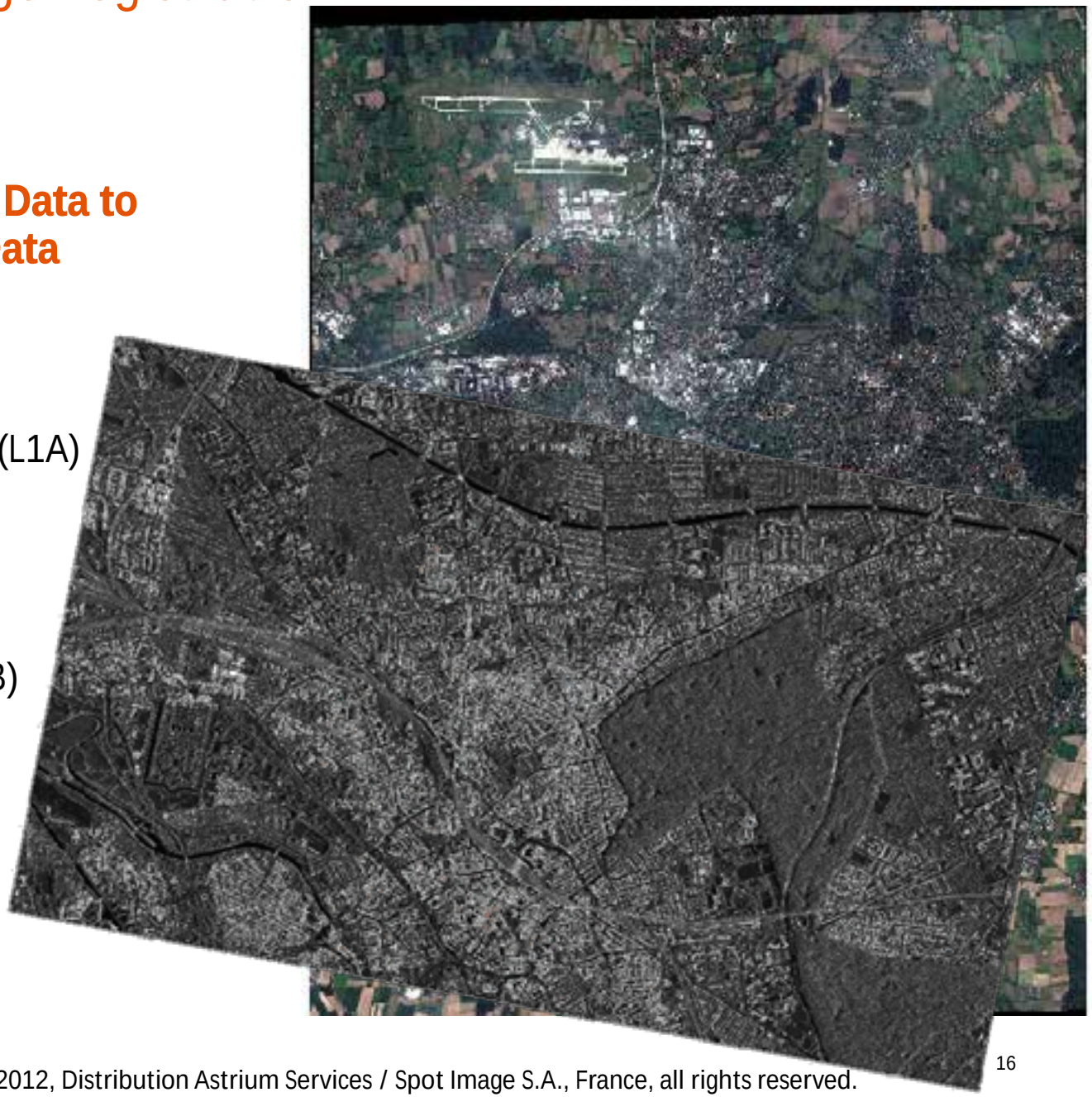
- Rome, Italy
- Base: TerraSAR-X StripMap Mode
- Warp: SPOT-5
- Method: Mutual Information
- Geometric model: Fitting Global Transform
- 68 tie points



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



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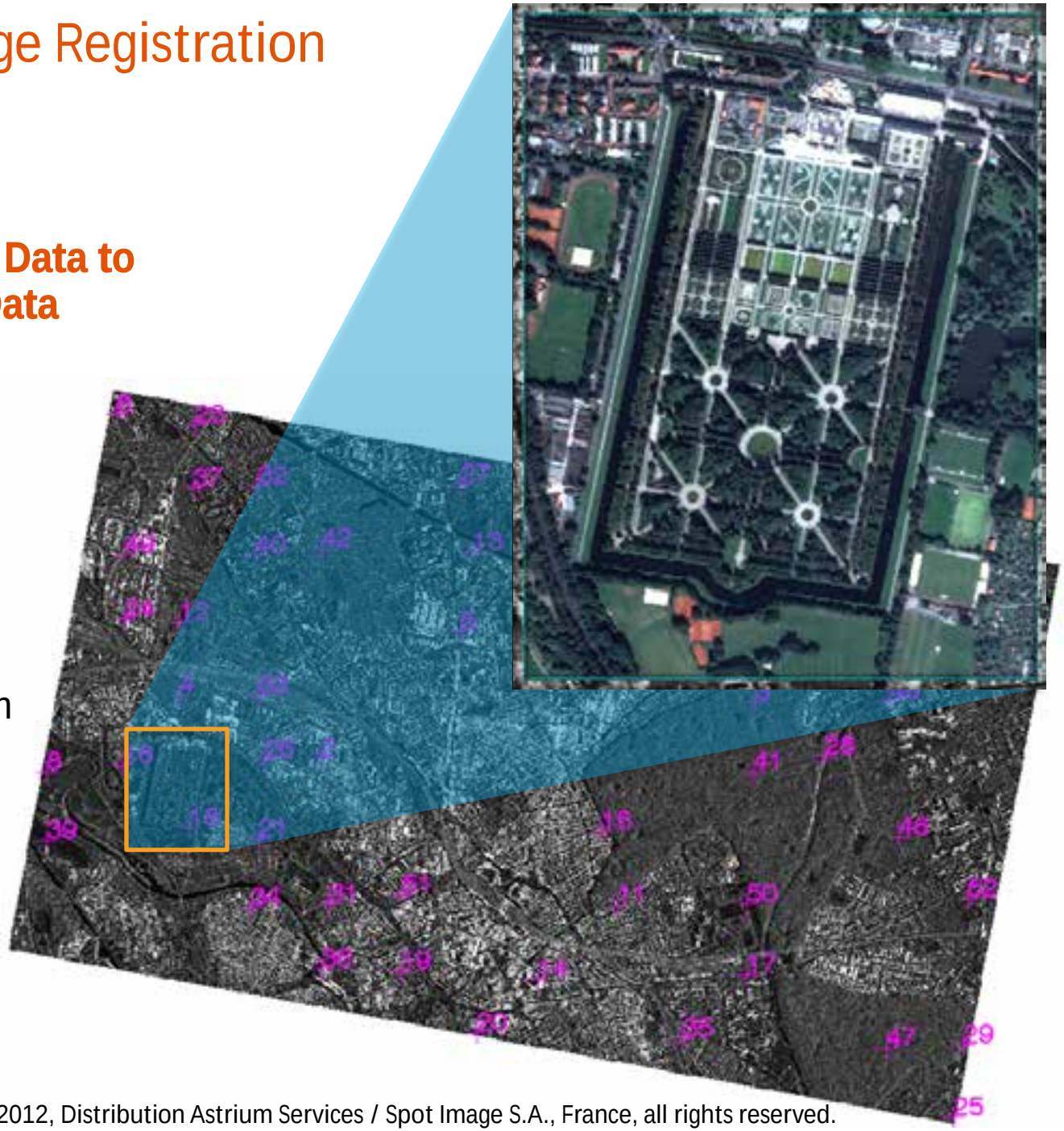
Multi-Sensor Image Registration

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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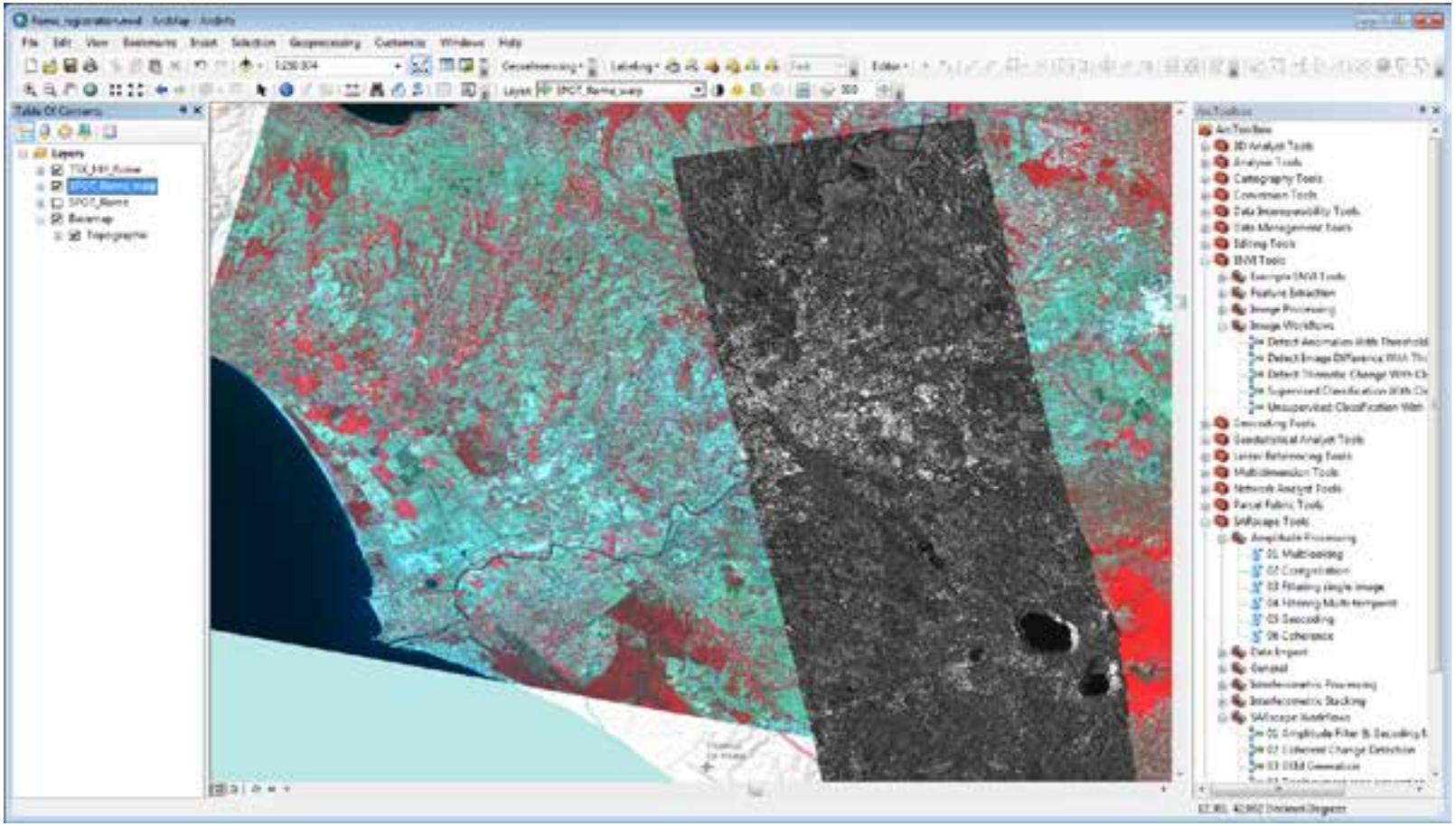
Motivation

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



Implementation in ArcMap

Software Products Used

> ArcGIS 10.x

> ENVI 5.0

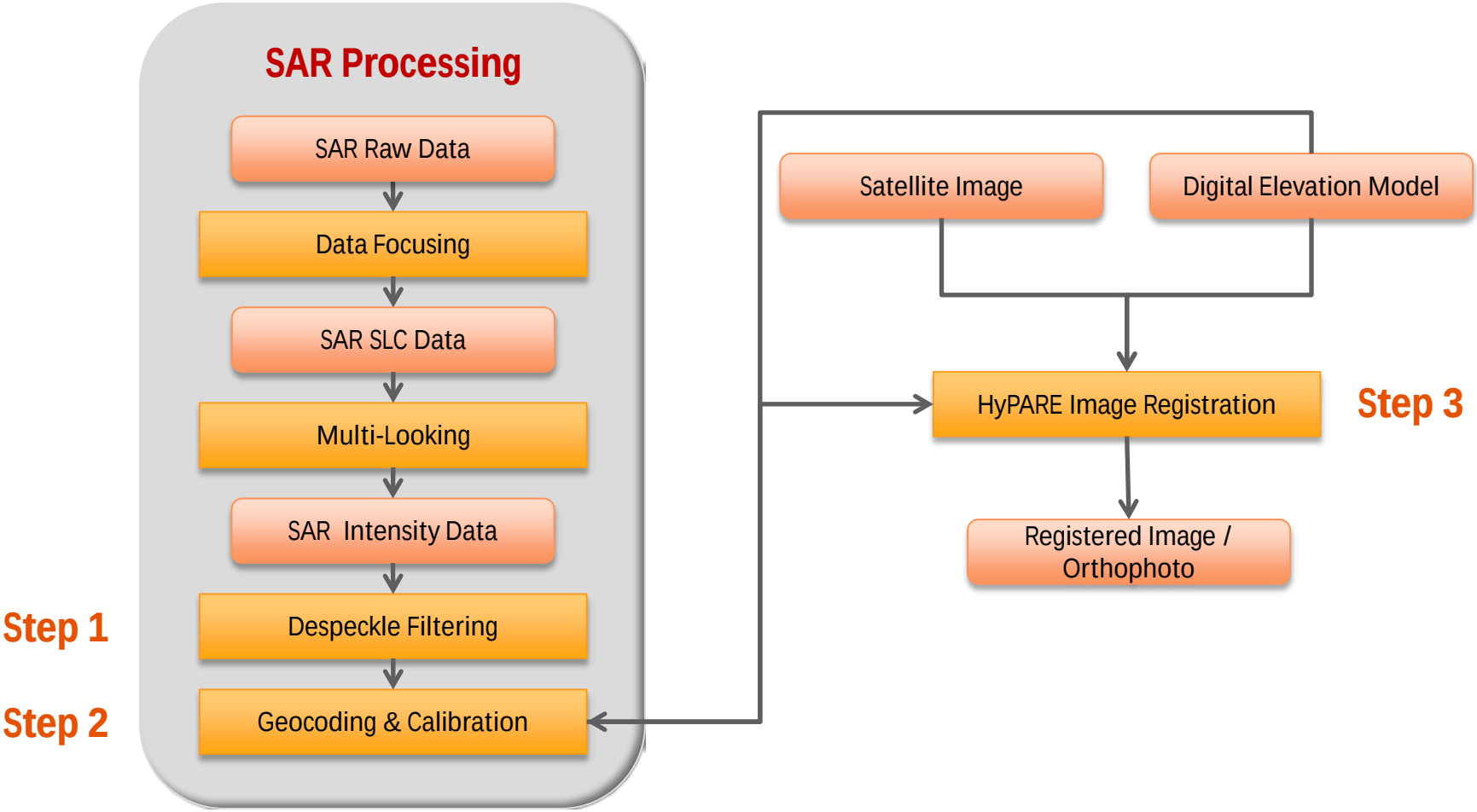
> ENVI SARscape 5.0

> IDL 8.2

Allows users to analyze imagery and easily share data between, ArcGIS, ENVI, and ENVI SARscape

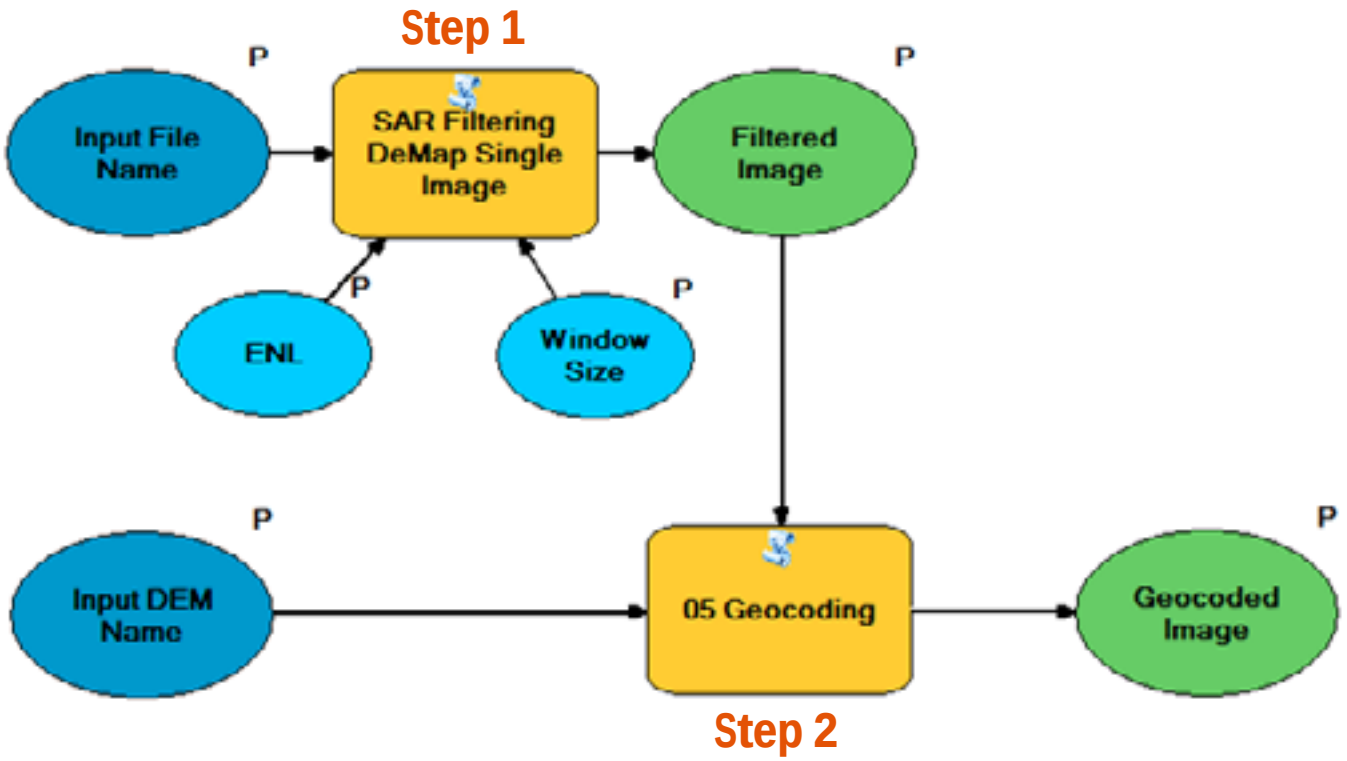
Implementation in ArcMap

Combined Workflow for SAR Processing & HyPARE Image Registration



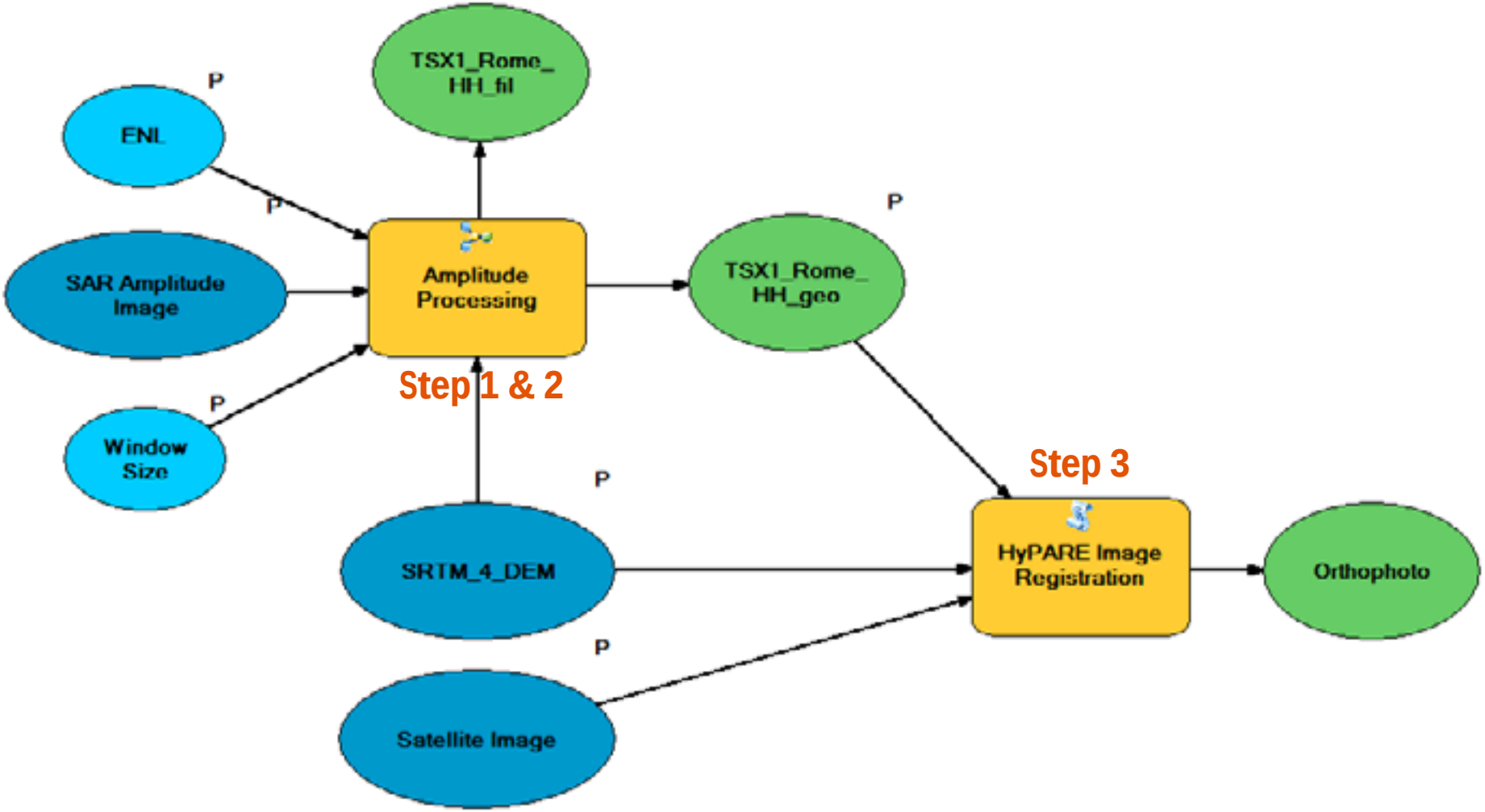
Implementation in ArcMap

SAR Processing



Implementation in ArcMap

Multi-Source Image Registration



Implementation in ArcMap

Step 1: Filtering

> **Gamma D**istribution-**E**ntropy **M**aximum **A P**osteriori (Gamma DE-MAP) Filter

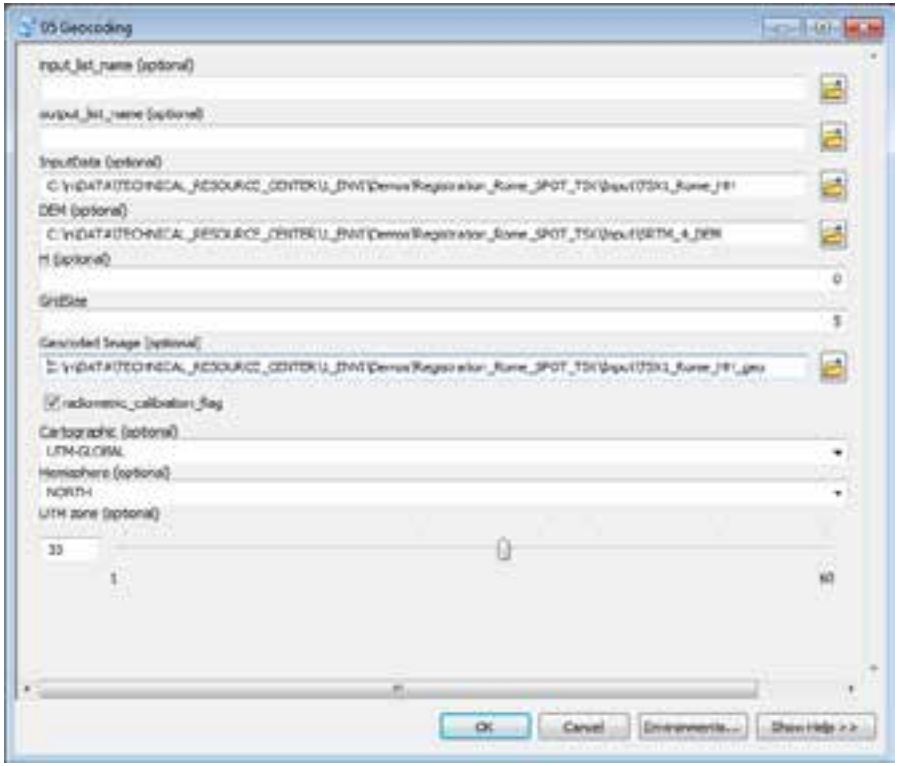
```
import sarscapepy, arcpy

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
```

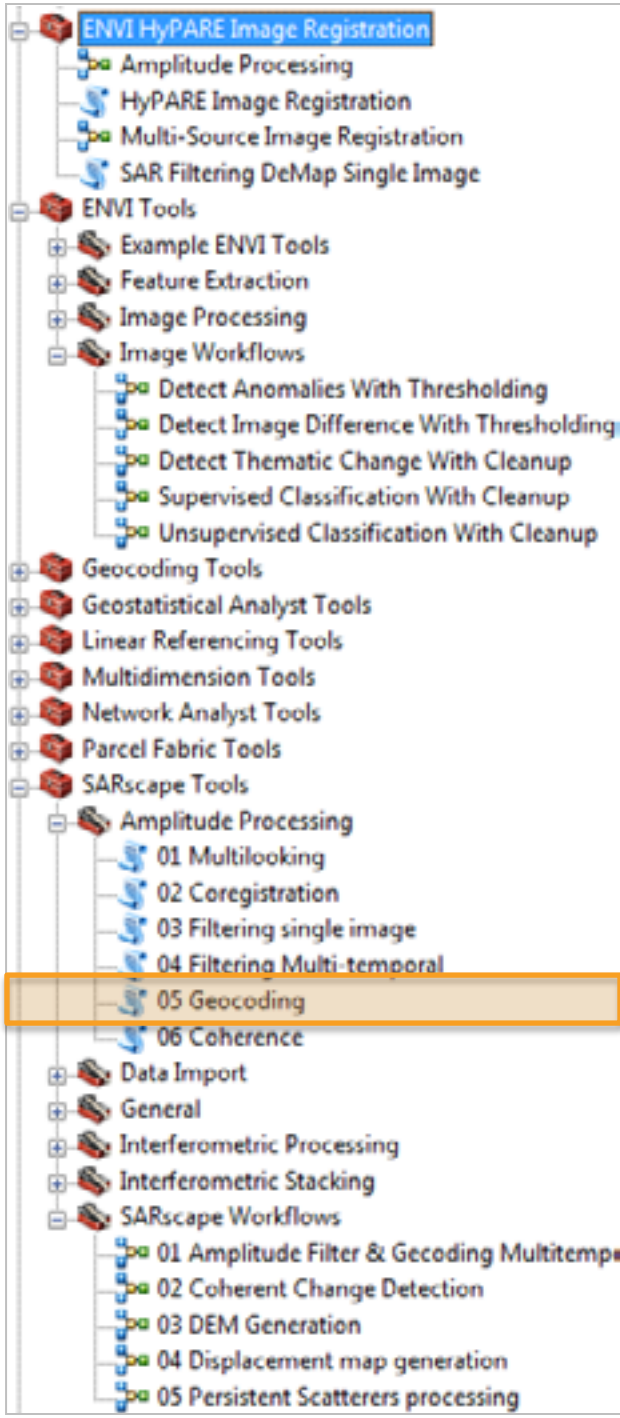
```
PRO single_image_filter, inRasterName, outRasterName, eq_looks, win_size
  COMPILE_OPT idl2
  ENVI_CHECK_SAVE, /TRANSFORM
  ENVI_BATCH_INIT, /NO_STATUS_WINDOW

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

  ok = oB->VERIFYPARAMS()
  ok = oB->EXECUTE()
END
```

Implementation in ArcMap

Step 2: Geocoding & Radiometric Calibration

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





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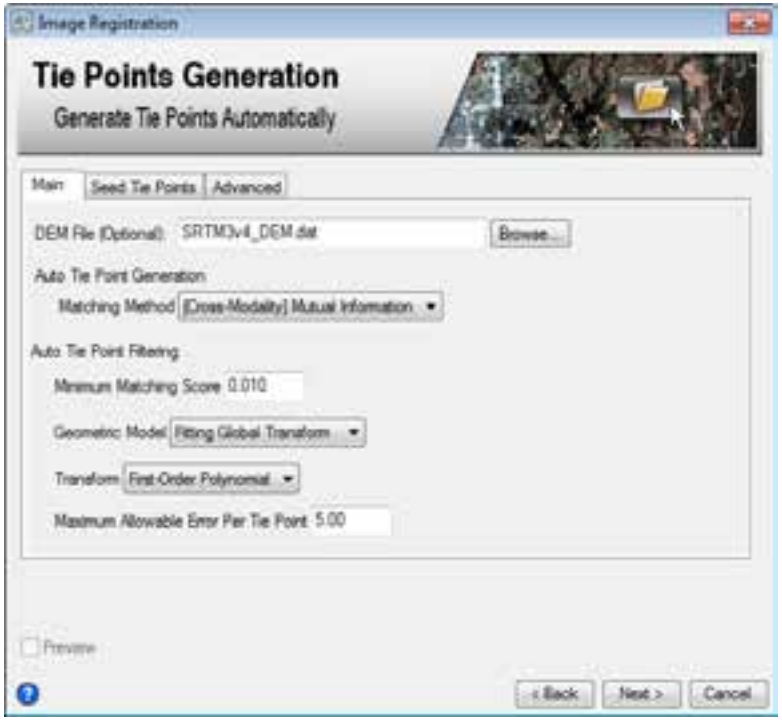
Implementation in ArcMap

Step 3: HyPARE Image Registration

> The release of the ENVI/IDL API for HyPARE image registration in batch mode is planned for 2014.



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Summary

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.

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Questions & Discussion

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