

## GeoImaging Tools Version 2.0

### GeoImaging Tools - Image Correction Module

The GeoImaging Tools, Image Correction Module offers accurate and efficient means of correcting raw imagery – opening new doors for the integration of remotely sensed imagery into GIS workflows. With the GeoImaging Tools, Image Correction Module, you can perform rigorous corrections and ensure multiple types of data are properly registered for further analysis within ArcGIS.

Customers now have the option to save the correction parameters into the Raster Processing Definition (RPDef) format, reducing data duplication using PCI's powerful sensor model definitions.

The following functions are included in the PCI GeoImaging Tools, Image Correction toolbox:

- I. Ingest Raw Scenes
- II. Refine Raw Scenes with GCPs
- III. Refine Raw Scenes with Tie Points
- IV. Write RPDefs

### Pre-Requisites

GeoImaging Tools Version 2.0 and beyond are built to work directly in the ESRI ArcGIS environment. Specifically, Version 2.0 is built to work as GeoProcessing tools within ArcGIS.

To utilize GeoImaging Tools Version 2.0, users will need to have ArcGIS Version 10+ installed on their system, along with Python Version 2.6.

In order to utilize the capabilities of the GeoImaging tools product, users will need to be licensed for ArcGIS 10. In order to use the output from GeoImaging Tools, users need to be licensed at the ArcEditor or ArcInfo level.

### Ingest Raw Scenes

The "Ingest Raw Scenes" module is used to ingest raw satellite scenes, and output PCIDSK (.pix) files that include a nominal transformation with which you can orthorectify the scenes.

In most cases, the system will output a linked .pix file, which contains a reference to the original source raster, thereby not duplicating data, and can also include metadata, math models, and GCPs.

The following lists all of the sensors supported by the Ingest Raw Scenes function.

### Optical Satellite Sensors

The following optical Satellite sensors are supported by GeoImaging Tools, Version 2.0:

- ALOS AVNIR-2:
  - Level 1A, 1B1, and 1B2R format
- ALOS PRISM
  - JAXA Format for Level 1A, 1B1 and 1B2R
- ASTER:
  - Level 1A format
  - 1B HDF format
- CARTOSAT-1:
  - Level 1, 2, 3, 4, 5, 6
- CBERS 1 and 2
  - Level 1A support
- GeoEye-1 (TIFF, NITF)
  - GeoEye-1 Mono
  - GeoEye-1 Stereo
- HJ 1A and 1B
- IKONOS GEO:
  - GEO product in Geotiff or HDF format
- IRS Super Structure:
  - Level 0
  - Level 1
- IRS (EOSAT):
  - IRS full-scene data
  - ORBIT-ORIENTED or MAP-ORIENTED product
- Kompsat-2:
  - Level 1A equivalent (level 1R) distributed in Tiff format
- LANDSAT 5 (Brazilian):

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- Full-scene data with level 4 or 5 processing levels
- LANDSAT 5 (EOSAT):
  - LANDSAT 5 image full-scene data
  - ORBIT-ORIENTED or MAP-ORIENTED product
- LANDSAT 5/7 (LSGOWG) Canadian CDs:
  - LANDSAT full-scene or sub-scene image data
  - Level-4 processing (bulk, radiometric, and along-scan-line geometric corrections applied)
  - Level-5 processing (georeferenced) CD
- LANDSAT 5/7 (LSGOWG) ESA CDs:
  - Level 5 full-scene or quad-scene data
- LANDSAT 5 (NLAPS, TIFF):
  - NLAPS full-scene data with level-8 processing levels
  - TIFF full-scene data with systematic correction
- LANDSAT 7 (HDF, TIFF, FAST, NLAPS):
  - Full-scene data with 1G progressing in HDF, TIFF, FAST, or NLAPS format
- QUICKBIRD (Basic and Ortho-Ready product):
  - GeoTiff or NITF with support files (ATT, EPH, GEO, IMD, RPB, TIL)
- SPOT 4 (SPOTIMAGE)
  - Level 0
  - 1A
  - 1B
- SPOT 5:
  - 1A and 1B Products
- SPOT 5 (TIFF)
  - Level 1A SPOT 5 Dimap format
- WorldView-1, WorldView-2
  - Direct support for GeoTIFF and NITF formats
- SGC (SAR Georeferenced Coarse Resolution)
- SGF (SAR Georeferenced Fine Resolution)
- SGX (SAR Georeferenced Extra Fine Resolution)
- SLC (Single Look Complex)
- SCN (ScanSAR Narrow Beam Product)
- SCW (ScanSAR Wide Beam Product)
- RADAR (CEOS) RADARSAT-2
  - SLC (Single Look Complex)
  - SGF (SAR Georeferenced Fine, ScanSAR Narrow Beam, and ScanSAR Wide Beam)
  - SGX (SAR Georeferenced Extra Fine)
  - SGC (SAR Georeferenced Coarse)
  - SSG (SAR Systematic Geocorrected)
  - SPG (SAR Precision Geocorrected)
- TerraSAR-X (TIFF)
  - MGD

## Refine Raw Scenes with GCPs

Automatic ground control point collection is found in the Refine with GCPs function.

This function allows a user to Collect ground control points (GCPs) from various reference sources and use them to refine ingested raw scenes. The "Refine Raw Scenes with GCPs" function writes a refined math model segment to each of the input raw scenes.

The input data must be created using the Ingest Raw Scenes tool.

The following is the workflow for this function:

- I. Extract GCP's from various sources
- II. Merge all extracted GCP's
- III. Refine GCPs using selected parameters
- IV. Update math model(s)

## Extracting GCP's

This can be done from 1 or more reference data layers, including:

## Radar Satellite Sensors

The following Radar sensors are supported for ingest in GeoImaging Tools Version 2.0:

- ASAR
  - ASAR 1B format
- RADARSAT (CEOS):

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- Reference Imagery
  - Reference imagery could be a folder containing raster files, or an ArcGIS image service that overlaps at least some of the input rasters.
  - GCP's are collected using advanced image correlation to identify pixel and line locations in raw images that correspond to georeferenced image positions
  - Collects points in an evenly spaced pattern over an entire image
  - Uses a DEM to automatically supply elevation values of GCPs
- Polygon or Line vectors
  - GCP's are collected by matching imagery to rasterized vector data in the spatial frequency domain using the Fast Fourier Transform (FFT). The matching algorithm is based on the Kuglin and Hines (1975) paper, listed in the Reference Paper section below.

## Merging GCP's

If ground control is collected from multiple sources, those points are merged into a single set of GCP's for use in the calculation of an updated math model. If a user collects points from a single source, this step is skipped.

## Refining GCP's

This step attempts to remove points with large errors, to generate a more accurate math model. The following rejection methods are supported:

- RMS Error – Rejects points whose RMS error is greater than specified X and Y RMS error values. The point with the largest error is removed first and the model is re-calculated. This is done until all points are under the specified RMS error values.
- Absolute Distance – Rejects points whose residual error (in pixels) is larger than the specified X and Y error values. The point

with the largest error is removed first and the model is re-calculated. This is done until all points are under the specified residual error values.

## Update math model(s)

Once the GCPs are collected and refined, the system will recompute the math models for the input images. These models are written to a segment in each of the input files.

## Refine Raw Scenes with Tie Points

Automatic TP collection is found in the Refine Raw Scenes with Tie Points function.

This function collects tie points from a set of overlapping scenes and uses them to refine the scenes' georeferencing. Tie points connect clearly identifiable locations in multiple images.

The input data must be created using the Ingest Raw Scenes tool. However, it could be modified using the Refine Raw Scenes with GCPs tool, which writes a refined math model segment to each of the input raw scenes.

The process for this function contains three elements:

- I. Extract Tie Points for all input scenes
- II. Refine the Tie points
- III. Update the math model(s)

## Extracting Tie Points

Tie points are collected using automated image-correlation techniques.

This function collects points for each input image; points are initially collected between the image and all of its overlapping neighbors. The positional information that exists within each of the input images determines where to begin searching for tie points.

Pixels in the overlap or search area are inspected for similarity within a small window (template) from the raw image. The pixel with the highest degree of

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similarity is accepted if it passes the specified minimum acceptance score.

## Refine the Tie Points

Once the function has collected tie points for all the input images, it will then refine these points, similar to the refinement that happens with the GCPs.

This tool refines initial tie points by eliminating points with large residual errors, enabling the user to generate a more accurate math model. The following rejection methods are supported:

- **RMS Error** – Rejects points whose RMS error is greater than specified X and Y RMS error values. The point with the largest error is removed first and the model is re-calculated. This is done until all points are under the specified RMS error values.
- **Absolute Distance** – Rejects points whose residual error (in pixels) is larger than the specified X and Y error values. The point with the largest error is removed first and the model is re-calculated. This is done until all points are under the specified residual error values.

## Update math model(s)

Once the Tie Points are collected and refined, the system will recompute the math models for the input images. These models are written to a segment in each of the input files.

## Write RPDefs

This function creates Raster Process Definition (RPDef) files from input raster files that have a math model segment.

The RPDef files that are created include a reference to the original raster and auxiliary information including rational polynomial coefficients (RPCs), which allows ArcGIS to orthorectify the raster data on the fly.

The input data must be created using the Ingest Raw Scenes tool. However, it could be modified using the Refine Raw Scenes with GCPs and Refine Raw Scenes with Tie Points tools.

One RPDef file is created for each scene discovered in the input folder.

- Each RPDef points to the raster data, which may be stored in multiple files on disk.
- Each RPDef contains RPCs generated from the math model contained in the input scene.

Unless metadata explicitly indicates otherwise, the vertical datum for the digital elevation model (DEM) is assumed to be mean sea level (MSL) for files and ellipsoidal height (ELL) for an Image Service. Any necessary adjustment will be done on the fly.

## Reference Papers

Kuglin, C.D. and D.C. Hines (1975). "The phase correlation image alignment method". Proceedings of the IEEE 1975 International Conference on Cybernetics and Society, San Francisco, California, pp. 163-165.

### For more information, contact

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