GXL Satellite Orthorectification

GXL Satellite Orthorectification includes rigorous and rational function models developed to compensate for distortions and produce orthorectified satellite images for high resolution and low resolution sensors. Distortions caused by the platform (position, velocity, and orientation), the sensor (orientation, integration time, and field of view) the Earth (geoid, ellipsoid, and relief), and the cartographic projection (ellipsoid and cartographic) are all taken into account using these models. The models reflect the physical reality of the complete viewing geometry and correct all distortions generated during the image formation.

Module Prerequisites

GXL Satellite Orthorectification is an add-on to the base system. It requires a GXL system as a pre-requisite.

Supported Satellite Formats

GXL Satellite Orthorectification supports a wide range of high and low-resolution optical satellite sensors. For more details on specific sensors, see the Sensor support webpage.

Supported Sensors

- ALOS:
  - AVNIR-2 Level 1A, 1B1, and 1B2R format (requires ALOS license)
  - PRISM – JAXA Format for Level 1A, 1B1 and 1B2R
- ASTER:
  - Level 1A format (recommended)
  - 1B HDF format
- AVHRR
- CARTOSAT-1:
  - Level 1, 2, 3, 4, 5, 6
- CBERS 1 and 2
  - Level 1A support
- DEIMOS-1
  - L1R format, TIFF or RPC format
- Disaster Monitoring Constellation
  - Level 1R support
- EOC
- EROS A:
  - 1A Product
- EROS B:
  - 1A Product

- EROS Level 1A
- FORMOSAT Level 1A
- FORMOSAT-2 Level 1A
- GeoEye-1 (TIFF, NITF)
  - GeoEye-1 Mono
  - GeoEye-1 Stereo
- GOSAT
  - Greenhouse Gases Observation Satellite
  - Also known as IBUKI
  - Images over 56,000 observation points
  - Level 1B
- HJ-1A/B - First two sensors of the Chinese Environment and Disaster Monitoring Microsatellite Constellation
- IKONOS GEO:
  - Most economical GEO product in Geotiff or HDF format
  - 1-2m accuracy with 10 or more ground control points (GCPs)
- IKONOS GEO Ortho Kit:
  - Satellite Orbital Math model can be used without rational function coefficients
- IRS Super Structure (recommended):
  - 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):
  - 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
  - SYSTEMATIC geodetic processing
- 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
  - 0R or 1R is not recommended because of discontinuity on the image
- MERIS 1B format
- ORBVIEW-3:
  - Basic Enhanced 1A Product
- Pleiades
  - Pleiades 1A Format
- QUICKBIRD (Basic and Ortho-Ready product):
  - GeoTiff or NITF with support files (ATT, EPH, GEO, IMD, RPB, TIL)
- SPOT 1 to 3 (LGWOWG) Canadian formats, Level 1
- SPOT 1 to 4 (SPOTIMAGE)
  - Level 0
  - 1A (recommended)
  - 1B
  - Old SPOTIMAGE LGSOWG format and the new CAP-T format
- SPOT 5:
  - 1A and 1B Products
- SPOT 5 (TIFF)
  - Level 1A SPOT 5 Dimap format
- Thaichote(THEOS)
  - Level 1A
  - Level 1B
  - Level 2A
- WorldView-1, WorldView-2
  - Direct support for GeoTIFF and NITF formats
- ZY-1-02C
  - Read only, GDB TIFF or RPC file
- ZY-3
  - Read only GDB TIFF or RPC file

Rigorous Math Model

Rigorous math models:

- Calculate the position and orientation of the sensor when an image is taken
- Accurately account for known distortions in an image
- Use ground control points (GCPs) and tie points, combined with the knowledge of rigorous geometry of sensors, to calculate best fit for all images in a project

RPC Models

The Rational Function is a simple math model that:

- Builds a correlation between the pixels and their ground locations
- Obtains RPC data with images and imports coefficients automatically
- Calculates the polynomial coefficients from GCPs
- Refine RPC data with one or more GCPs
- Zero- or first-order GCP refinement available

RPC-based corrections are available for the following types of imagery:

- ALOS
  - AVNIR-2
  - PRISM
- CARTOSAT (completed 6 Level certification by ANTRIX)
- DEIMOS
- DMC
- EROS
- GeoEye-1
- IKONOS
- Kompsat-2
- NITF
- OrbView-3
- Pleiades
- QuickBird
- RapidEye
- SPOT
- WorldView-1
- WorldView-2
- ZY-1-02C
- ZY-3

AUTO TIE POINT

The OrthoEngine Productivity Suite supports automatic tie point collection.

Auto Tie-Point Collection

Tie points are collected using automated image-correlation techniques, which:

- Let you distribute evenly over an entire image or in overlapping image regions only
- Use moving frames with a search radius (100 pixels default)
- Specify a matching threshold (a minimum correlation score is required for a match)
- Use a DEM to extract elevation values of tie points
- Collect tie points for the working image or all images

AUTO-IMAGE REGISTRATION

The OrthoEngine Productivity Suite offers the following registration functionality.

Automatic Image-to-Image Registration

- Uses advanced image correlation to identify pixel and line locations in raw images that correspond to georeferenced image positions
- Allows for repeat mapping or compositing
- Lets you define the number of GCPs you want collected over each image
- Collects points in an evenly spaced pattern over an entire image
- Uses a DEM to automatically supply elevation values of GCPs
- Supports scripted or automated workflows
- Lets you accept or reject correlated matches displayed in table

Automatic GCP Collection from Chip Database

The chip database engine stores, updates, and retrieves image chips. Image chips are used to automate the collection of GCPs on raw imagery, which:

- Uses image correlation to identify pixel and line locations in raw image that correspond to georeferenced image chip positions
- Are useful when orthorectifying different images of the same geographic area
- Let you define search criteria, such as sensor, range of acquisition dates, and region of interest
- Let you accept or reject correlated matches displayed in table

Chip Database Creation

Chip databases are created using the powerful Geomatica Chip Manager interface.

- Allows you to insert, search/view, update, and delete image chips in an image chip database
- Automatic creation of image chips using a GCP segment and source image
- Attach sensor, date, projection and metadata of source image to image chips
- Enables the merging of two imagery chip database files
- Generates chip reports

GXL QA Bundle Ground Control

GXL Satellite Orthorectification supports GCP and tie-point ground controls.

GCP Collection

GCPs can be collected manually or by using:

- A geocoded image
- Geocoded vectors
- A chip database
- A digitizing tablet
- An imported text file

Other features include:

- Stereo-GCP collection
- Conversion of GCPs to check points to exclude from model calculation
- Display of individual and overall RMS error for GCPs

Depending on the sensor, the following minimum number of GCPs is required:

- SPOT 1-4: - 4 per image, depending on GCP quality
- SPOT 5: - 6 per image, depending on GCP quality
- IRS, ASTER, EOC: - 6 per image (6-8 recommended)
- LANDSAT: - 6 per image (10-12 recommended)
- Rational Functions Computed from GCPs: - 5 per image (19 per image is recommended)
- Rational Functions Extracted from Image File: - None required (accuracy is improved with 1 or more GCPs)

Tie-Point Collection

Tie-points:

- Extend ground control over areas without GCPs
- Identify how images in a project relate to each other
- Ensure the best fit for all images in a project
- Let you enter tie-point elevations manually or extract them from a DEM
- Let you import and export tie points
- Show individual and overall RMS errors

Residual Report

Using residual reports, you can:

- Show GCP, check point, tie point, and Stereo-GCP error information in one report
- Edit points in a residual report and update bundle adjustments
- View in ground units or pixel units
- Print the report to a file

Project Summary Information in the GXL QA Bundle

Raw Image Summary Table

A summary of information about all of the images in your project can be viewed in the Raw Image Summary Table window, included in the GXL QA Bundle. This window provides information about the following:

- Total number of images in the project
- Total number of ground control points (GCPs), tie points (TPs), and check points (CPs)
- Image-specific information, including image ID, GCPs, TPs, CPs, root mean square (RMS) error, number of overlapping pairs connected by TPs, number of potential overlapping pairs that could be connected by TPs, and the percentage of all overlaps connected by TPs

The Raw Image Summary Table provides you with a dynamic view of your project, allowing you to better target your quality assurance efforts to achieve your desired project requirements.

Image-specific information is displayed in tabular format. The tabular contents can be sorted, making it easier for you to analyze the data in your project and identify areas on which to focus your quality assurance activities.

Project Overview

The Project Overview window displays the geocoded vector footprints or image centers for all images in your OrthoEngine project, and provides options for displaying ground control points (GCPs), check points (CPs), tie points (TPs), image IDs, and point IDs, for the selected image or images or for all images. This viewer helps you better assess your project using a graphical overview.

ORTHORECTIFICATION

Orthorectification:

- Lets you perform batch processes
- Utilizes a DEM for terrain correction
- Increases working cache for processing
- Offers the following resampling methods:
  - Nearest Neighbor
  - Bilinear Interpolation
  - Cubic Convolution
  - 8-pt SinX/X
  - 16-pt Sin X/X
  - Average filter
  - Median filter
  - Gaussian filter

- Lets you set a starting time for processing
- Provides approximately one-third of a pixel accuracy for VIR satellite images, and approximately one pixel for radar images when quality ground control coordinates are used

FUNCTIONS

With a license for GXL Satellite Orthorectification, the following functions are activated:

- AUTOCHIP – automatic GCP collection from image chip database
- AUTOCHIP2 – OpenMP enabled automatic GCP collection from image chip database
- AUTOFID – automatic collection of image coordinates of fiducial marks
- AUTOTIE – automatic tie point collection
- AUTOTIE2 – OpenMP enabled automatic tie point collection
- AUTOGCP –automatic GCP collection using image-to-image registration
- AUTOGCP2 –OpenMP enabled automatic GCP collection using image-to-image registration
- AVMODEL – calculates model for orthorectifying AVHRR data
- CDSPOTRPC - reads SPOT DIMAP and CAP format data for orthorectification using the Rational Function model.
- CHIPEXT – automatic image chip extraction
- FFTMPOLY – automatic GCP collection by matching image with polygons
- FFTMVEC – automatic GCP collection by matching image with vectors
- GCPREFN – automatic GCP refinement
- GCPREFN2 – improved automatic GCP refinement allowing elimination of rejected GCPs
- HOTSPOT – hot spot correction
- MERGEBAND - Lets you merge and recombine multiple bands in separate files into a single file.
- PNT2CHIP – Convert points into a chip database
- QBASMBLE - lets you assemble QuickBird tiles into a single image with the associated RPC model information.
- RAW2CHIP – automatic chip extraction from a raw image and its GCP segment
- RFMODEL – computes the math model of one or more images using the rational function math modeling method
- RMOVERLAP – remove overlap from input polygons
- SATMODEL – calculates the math model for one or more images using the Rigorous math modeling method.
- STITCH - lets you merge the different tiles, which are obtained from the same orbit on the same day, into one complete scene.
- TPREFN – tie point refinement

PCI Geomatics gratefully acknowledges the financial support provided by the Canadian Space Agency through the Earth Observation Application Development Program (EOADP). This support was essential to the development of ENVISAT ASAR and MERIS support within PCI Software.

For more information, contact

PCI Geomatics
50 West Wilmot Street
Richmond Hill, ON L4B 1M5
Canada

Phone: 1 905 764 0614
Fax: 1 905 764 9604
Email: info@pcigeomatics.com
Web: www.pcigeomatics.com