

# **ORIMA orientation management**

Orientation and triangulation software for IMAGINE photogrammetry









# Productivity – The key to success

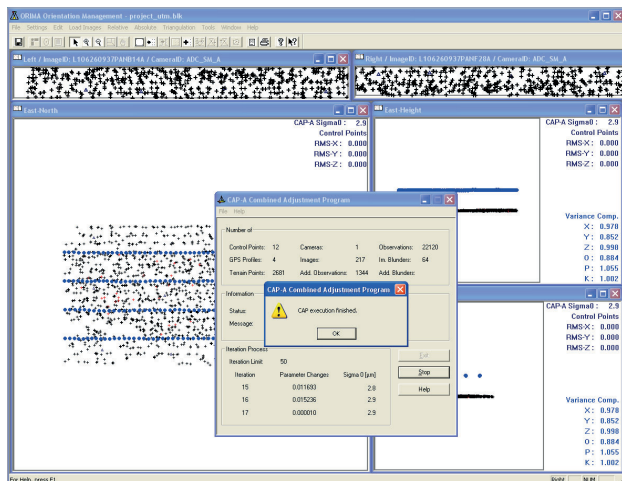
Success in photogrammetric mapping depends on high productivity in the basic operations of the workflow, starting with orientation and triangulation. Large data sets of image coordinates, ground control points and GPS coordinates must be processed. Throughout all phases, the critical requirements are detection and elimination of blunders and the minimisation of point re-measurement. ORIMA, orientation management software available exclusively from Hexagon, is an easy-to-use, leading-edge solution.

## ORIMA features

- State-of-the art bundle adjustment with self-calibration
- Processing of airborne GPS data and inertial measurement unit (IMU) attitude data, including GPS-drift and IMU misalignment parameters
- Multiple image display during point measurement
- ORIMA DP-M allows for triangulation of Leica Geosystems' airborne digital sensor (ADS) and frame images
- Powerful statistical techniques for blunder detection and elimination and the identification of weak areas in the block
- Fully automatic tie point measurement (APM)
- The new APM approach allows APM to be run on very large blocks, using sub-block processes that may be run concurrently or sequentially
- Support for multiple APM processes, allowing improved use of multiple processors or multi-core processors
- Semi-automatic control point measurement in stereo or mono
- Fast control point measurement of ADS scenes
- Superior memory management of ADS orientation data
- Easy-to-interpret graphics for analysis of the block
- Automatic weighting of GPS and IMU observations
- Flexible input formats from GPS and IMU data, including direct exchange format for Applanix POSPac software
- Rigorous transformation from ground to sensor, including map projections or geographic coordinates
- ORIMA for digital photogrammetry (DP) supports the stereo viewer of IMAGINE Photogrammetry
- For Digital Photogrammetric Workstation (DPW) systems, convenient re-measurement in weak areas
- Graphical output can be directed to printer or plotter
- Complete numerical reports available
- Easy inspection of adjustment results of ADS projects
- Simplified use of self-calibration, which finds the sub-set of significant parameters automatically
- Automatic discovery of the correct sub-set of significant additional sensor parameters
- A comprehensive set of ADS sensor parameters allows a simplified analysis of the results while improving the attainable accuracy
- Support for Windows 64-bit operating systems using a 64-bit version of Combined Adjustment Program — Aerial (CAP-A)
- Supports triangulation in non-Cartesian coordinate systems (such as geographic or national map projection systems)

ORIMA is fully integrated with IMAGINE Photogrammetry. All coordinate systems and datums supported by IMAGINE Photogrammetry are also fully supported by ORIMA, resulting in a mathematically rigorous solution for triangulation projects in non-Cartesian coordinate systems. All required coordinate transformations are handled transparently by ORIMA.

An option to compute a correction grid allows systematic compensating at image residuals that otherwise cannot be compensated by additional parameters. The correction grid is primarily intended for use of digital frame cameras that have multiple lens cones.



ORIMA graphical user interface for an ADS40 example

## The key to productivity

### Advantages and benefits

ORIMA exploits the operating system's extensive qualities, such as graphic user interface, multi-tasking, online and context-sensitive help, graphical output on printer or plotter and multi-lingual support (English, Spanish and French versions available).

- Available for IMAGINE Photogrammetry
- Fully compatible with IMAGINE Photogrammetry
- Bundle adjustment using proven, fast software, including self-calibration, airborne GPS and IMU
- IMU includes automatic weighting, highly automated blunder detection and elimination
- GPS-supported aerial triangulation, with or without time-dependent (drift) or time-independent additional parameters; flexible input formats from GPS post-processing software
- MU-supported aerial triangulation, with or without additional calibration parameters for misalignment between camera and IMU sensor axes
- ORIMA-DP allows triangulation in non-Cartesian coordinate systems such as geographic lat/long
- Excellent graphical displays for easy identification of weak areas through strong criteria based on statistical methods
- Displays error ellipses, customised external reliability, ray intersection geometry and effective image areas
- Complete, friendly, context-sensitive help and wizards

## Compatibility

The results produced by ORIMA can be used directly in IMAGINE Photogrammetry, with additional sensor parameters used by self-calibration also fully utilised by IMAGINE Photogrammetry. All other applications connected to IMAGINE Photogrammetry (e.g., IMAGINE Photogrammetry Terrain Editor or PRO600) fully utilise the accuracy achieved in the triangulation by ORIMA. This is also true for Frame and ADS projects.

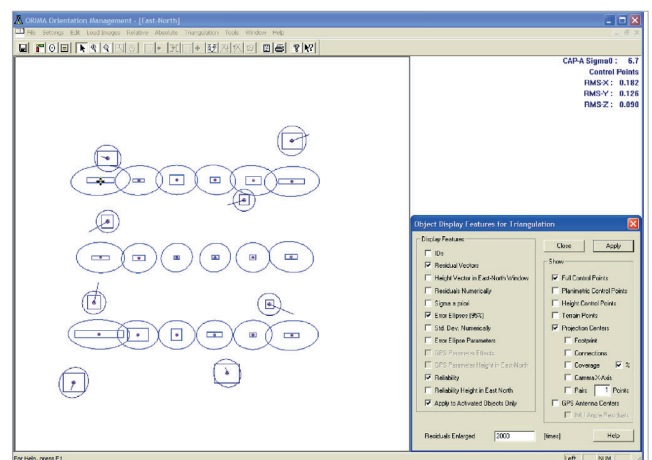
## Versions to suit all requirements

ORIMA is offered in three versions to suit customers with DPWs. Customers may select a version for traditional triangulation without GPS, a version supporting GPS and IMU processing or a version that supports ADS scenes.

## Functionality

- The ORIMA DP versions support the stereo viewer of IMAGINE Photogrammetry
- ORIMA DP-TB means Triangulation Measurement plus Basic Bundle Adjustment Software (CAP-A)
- ORIMA DP-TE/GPS means Triangulation Measurement plus Extended Bundle Adjustment Software with support for airborne GPS and IMU
- ORIMA DP-M, which stands for multi-sensor triangulation, supports triangulation measurements and bundle adjustment for FRAME images and ADS scenes

The table on the next page provides an overview of the functionality of the various versions.



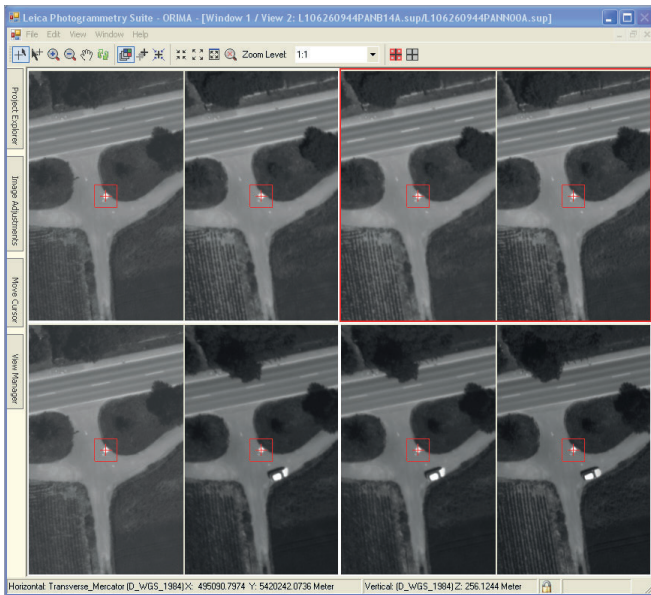
Ground view to analyse quality of block adjustment



FUNCTIONALITY	DP-TE/GPS	DP-M
APM using multi-threading technology	•	•
Wizard technology for predefined and user customisable workflows	•	•
Support for special input devices (like TopoMouse)	•	•
Specialised editors for camera data and control points	•	•
Emulation of workflow from analytical plotters, including relative and absolute orientation and manual tie point measurement with point transfer between images	•	•
All manual measurements are optionally supported by point-matching technology	•	•
Point-centric control point measurement using multi image displays in stereo or mono	•	•
Multiple graphical views in ground and image space, which directly interact with the graphical viewer of IMAGINE Photogrammetry during measurement and analysis with optional graphics overlay	•	•
Support for triangulation in any IMAGINE Photogrammetry supported coordinate system (like UTM, national grid projections, geographic or Cartesian system)	•	•
Bundle Adjustment CAP-A for unlimited number of frame images, with self-calibration parameters, automatic blunder elimination and quality criteria (like standard deviations and reliabilities)	•	•
Bundle Adjustment CAP-A (from above) plus additional support for airborne GPS and attitude data from IMU plus support for grid correction for Frame sensors with multiple lens cones	•	•
Bundle Adjustment CAP-A (from above) plus support for ADS using orientation correction technology		•







Control Point measurement in the IMAGINE Photogrammetry Stereo Viewer

## ORIMA For IMAGINE Photogrammetry

### Partners in state-of-the-art triangulation

ORIMA is fully integrated with IMAGINE Photogrammetry. This combination can perform a huge variety of operations, and ORIMA may be purchased with capabilities that suit your needs. There are now improvements to the manual point measurement process and interoperability between ORIMA and IMAGINE Photogrammetry.

### Coordinate systems

ORIMA supports triangulation in all coordinate systems and datums supported by IMAGINE Photogrammetry. The IMAGINE Photogrammetry project coordinate system is automatically detected by ORIMA, and all required datum and coordinate transformations are handled transparently. Approximation of the Cartesian model by earth curvature corrections is not required.

### Block setup for automatic point measurement

ORIMA for IMAGINE Photogrammetry allows the user to initialise the block layout in several ways:

- GPS files
- GPS and IMU files

- ASCII camera position file
- Known setup information in IMAGINE Photogrammetry Blockfile
- Measuring connection points using templates and wizards

### Automatic point measurement

ORIMA also supports APM and point transfer function of DPW systems, which automatically measures and transfers all tie points and automatically transfers all control points. The user can specify patterns of tie points as desired. APM produces large quantities of multi-ray points yielding reliable block configurations. Automatic blunder elimination by ORIMA's bundle program quickly and reliably uses robust estimation to eliminate all blunders from these very dense data sets.

ORIMA supports multiple APM processes, which allows for improved use of multiple processors or multi-core processors. The new APM approach allows APM to be run on very large blocks, using sub-block processes that may be run concurrently or sequentially.

### Multi-image measurement with ORIMA

ORIMA's IMAGINE Photogrammetry connection allows the user to view as many overlapping images as desired. The user may roam in all images simultaneously using any IMAGINE Photogrammetry supported viewing mode like stereo or split screen, mono or tri-view modes.

This allows optimum point selection when selecting multi-ray points in difficult blocks of imagery. ORIMA supports a semi-automatic tie or control point transfer using image matching. This provides reliable and efficient measurement or re-measurement. The matching algorithm may be applied in a primary/secondary mode with a single primary, with all other images as secondaries, or in a pair-wise fashion, whichever is more suitable.

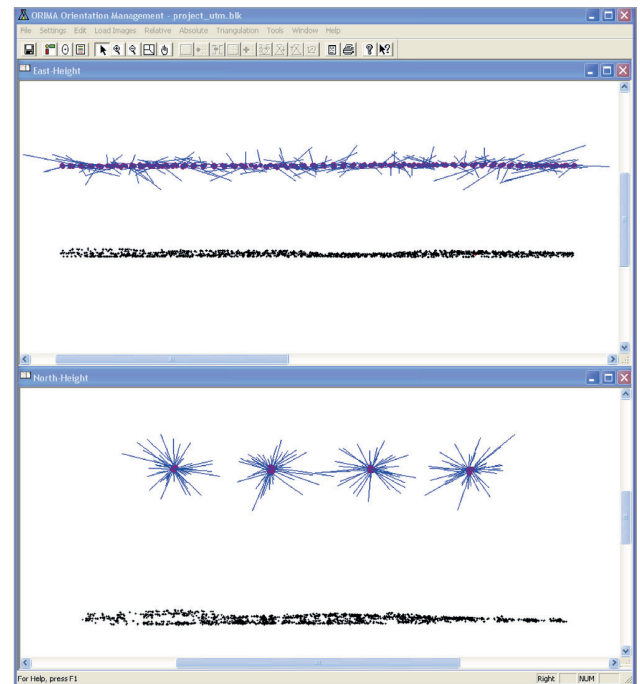
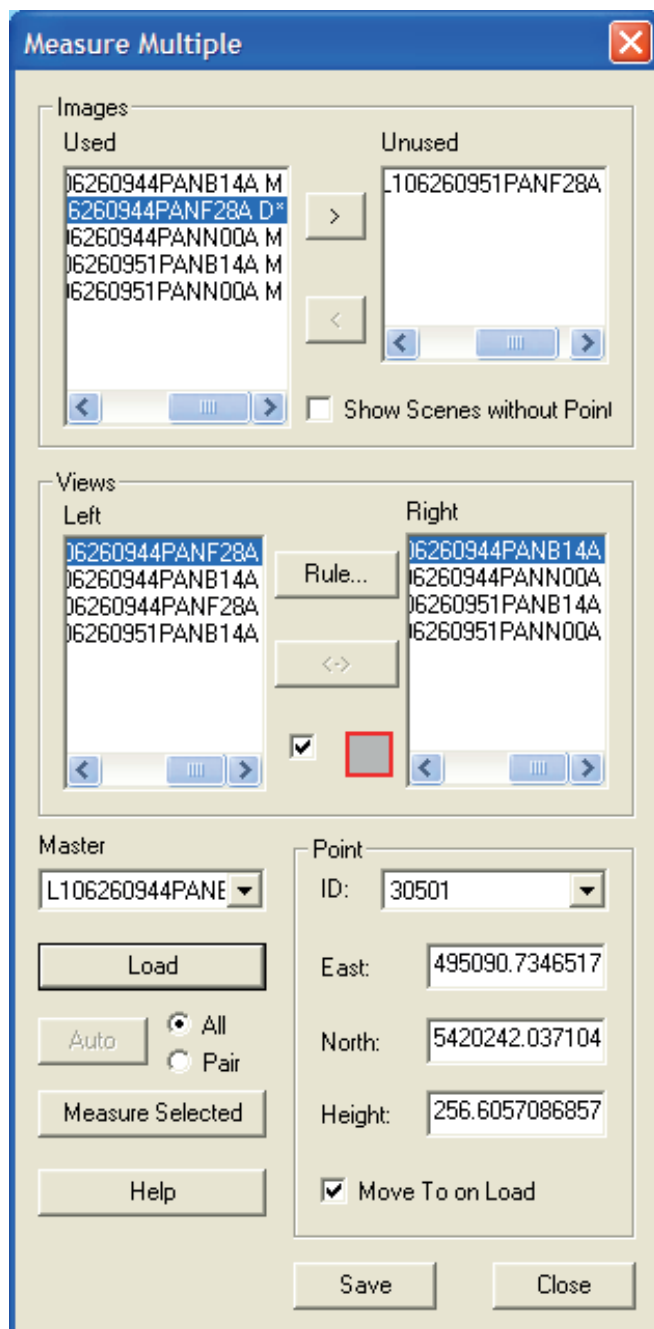
## Templates for tie point placement

ORIMA supports user-defined templates for placing tie points for manual and automatic measuring. In manual mode, this helps the user define a naming convention and placement for tie points. When combined with the use of wizards, ORIMA can step the user through an entire block of images in a very user-friendly and efficient process. In automatic mode, the user may define the number of points to obtain per image. Automatic point numbering assures the uniqueness of point IDs throughout the whole block.



## Adding tie points graphically

ORIMA allows the user to add a tie point by merely pointing at a graphical display of the block. By reviewing the distribution of tie points, number of multi-ray points and reliable coverage of the triangulation, the user can quickly point to a position where a point should be added. This prompts ORIMA to automatically display all overlapping images in the region requested, and the user can simply add a new multi-ray point. Alternatively, the automatic image matching can be invoked to add the point automatically.



Graphical analysis showing east and north height views

## Choose from three versions of ORIMA-DP

Three versions of ORIMA for DPW systems are offered to ensure a suitable combination of functions for each application, and no resources are wasted in the purchase of unnecessary functionality.

- **ORIMA DP-TB:** This version is for interactive online triangulation. TB adds full bundle adjustment, automatic error detection and elimination by means of robust estimation.
- **ORIMA DP-TE/GPS:** This version is for GPS/IMU-supported online triangulation. TE/GPS provides complete functionality with processing of airborne GPS and IMU data.
- **ORIMA DP-M:** This version is for multi-sensor triangulation. It supports triangulation measurements and bundle adjustment for frame images plus ADS scenes.

## ORIMA – Versatility at its best

### Bundle adjustment

ORIMA versions with bundle adjustment include the bundle module CAP-A version. All approximate values required for bundle adjustment are automatically

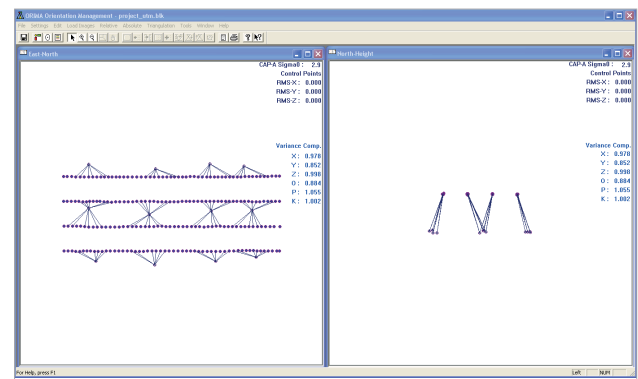


computed by CAP-A. Modern adjustment algorithms ensure a very fast solution with all data types and a full set of additional parameters. Definition of certain CAP-A execution parameters is done from inside ORIMA. During execution of CAP-A, a status display reports the progress of the computations.

Dynamic memory management accommodates unlimited block size, except for limitations related to the computer hardware or operating system. CAP-A can use all physical memory installed in the PC. If this is not enough to handle the job, parts are automatically swapped to the hard disk. There is no restriction concerning overlap or strip configurations.

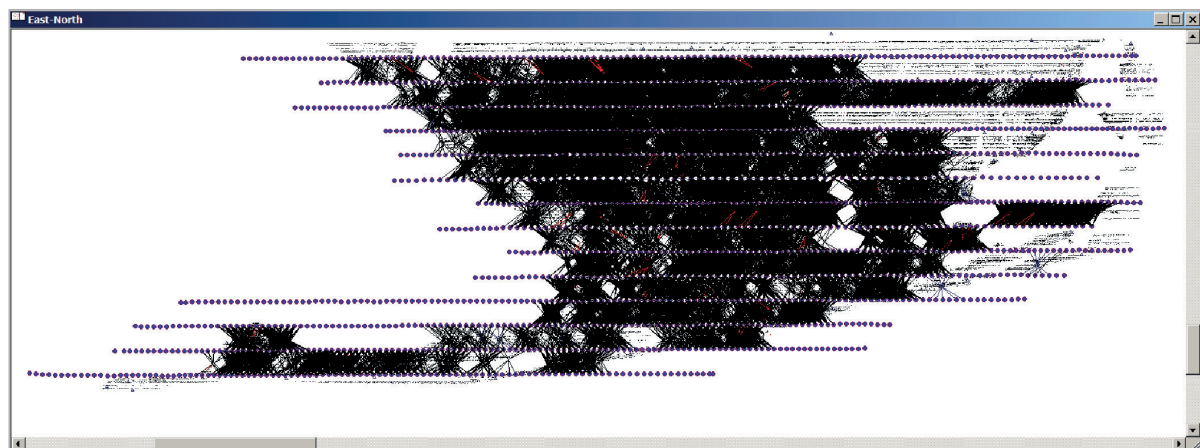
## Self-calibration

Self-calibration parameters may be used to correct systematic errors in image coordinates. They allow for simultaneous camera calibration (principal distance, coordinates of principal point and distortion parameters). Computed correlation coefficients are used to identify which self-calibration parameters are significant.



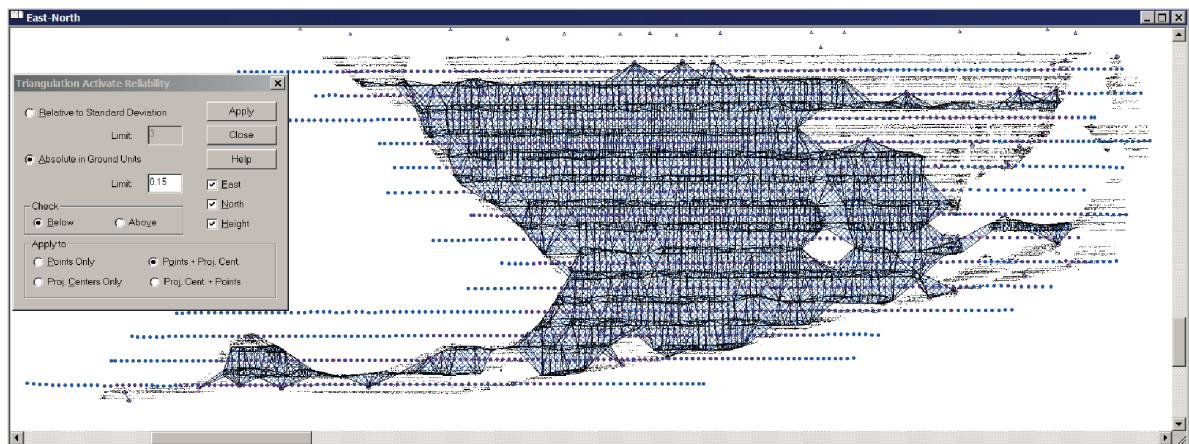
Geometry of intersecting rays (top and side views)

**Modern adjustment algorithms ensure a very fast solution with all data types and a full set of additional parameters.**



Graphical analysis showing strip connections





Effective footprints of the images showing coverage

## Airborne GPS

ORIMA supports aerial triangulation projects with airborne GPS. Data can be read in several formats, including Leica Geosystems' Flykin Suite+. To compensate for various systematic effects, either six time-dependent so-called drift parameters or seven time-independent so-called datum transformation parameters are used per GPS profile. A GPS profile is a set of photographs for which one set of drift parameters is applied. Often, a profile coincides with a strip. CAP-A supports any profile configuration. One strip may have multiple profiles, and a profile may also span multiple strips. The correct number of profiles is statistically checked, and the compensated systematic effect is graphically analysed with ORIMA. Variance components are used to find the correct weight relationship between the GPS observations and the photogrammetric observations.

The time-dependent drift parameters compensate mainly for unresolved ambiguities, remaining datum errors (unknown geoid) and errors in the antenna offset.

The drift parameters allow for normal flight operation, and the static receiver can be more than 200 km outside the block.

Only a minimum of control points in each corner of the block is required to transform the block into the control coordinate system. To solve for the configuration defects

between strips with 20% sidelap, cross strips at the ends of the block can be used instead of chains of height control points.

If it can be assumed that drift parameters are not needed for a certain project, then the GPS observations can be used directly to define the positions of the projection centers. In this case, no control points are needed, as the datum is directly defined from the GPS observations in the aircraft.

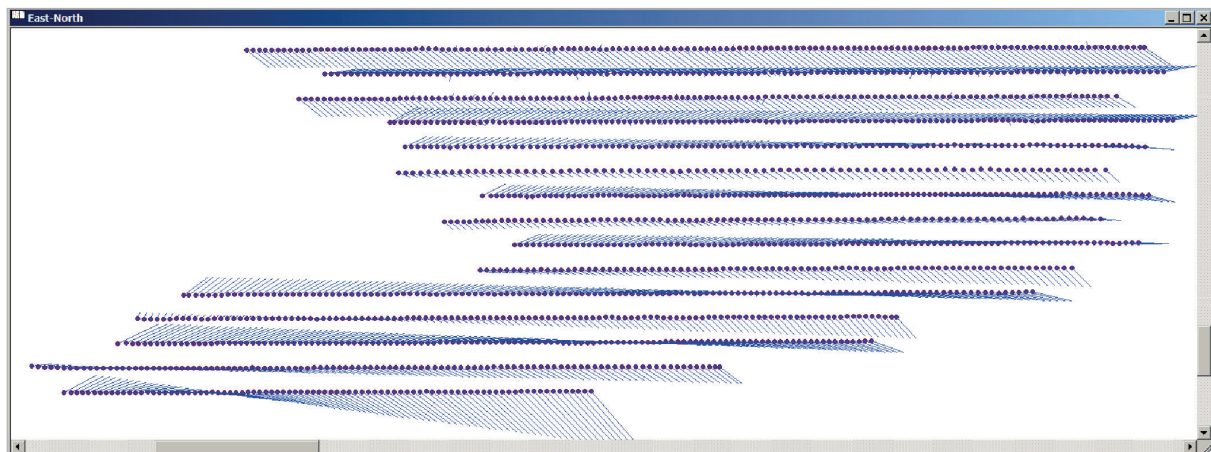
## Attitude observations from IMU

ORIMA supports the introduction of observed attitude data for each image, in addition to airborne GPS positional data. Attitude observations improve the stability and reliability of the block.

Misalignment parameters can be used to solve and correct for the misalignment between the camera and IMU sensor axes. Misalignment parameters may be determined for the whole block, for each strip or for any user-defined group of images (e.g., individual aircraft take-offs).

The misalignment parameters can be stored in the camera file and treated as known information in subsequent triangulation projects. This is especially useful for single-strip triangulation projects for support of activities such as corridor mapping.





Graphical view showing systematic that was compensated on the GPS observations

## Blunder detection

A statistical method is used to detect measuring errors (blunders) automatically. Blunders are automatically excluded from the adjustment by robust estimation techniques. The geometry of the block is taken into account by using the inverse of the normal equations within the computation of the blunder test. The blunder detection is applied to all types of observations (ground control, image coordinates, geodetic observations, GPS antenna observations and IMU angle observations).

The internal reliability, which is computed for every observation, shows the capability of the blunder test to detect blunders on each individual point. By means of this criterion, weak (unreliable) areas of the block can be identified. A customised external reliability statistic shows the maximum effect of a potential measuring error on the parameters (tie points and projection centers), providing guidance through the whole process.

## Graphics, quality and reliability, error analysis

The results of the triangulation may be analysed either by numerical listing or in the more convenient interactive graphical way, both defined by the user. The geometry and quality of the block may be analysed through complete control of the graphical displays.

The quality of the calculated orientation parameters is presented graphically, based upon computed standard

deviations and error ellipses. Reliability criteria are used to locate points and projection centers where potential errors are hard to detect. Internal reliability indicates the ease with which observations with blunders can be successfully identified. Blunders that were eliminated are displayed with a predefined color. The customised external reliability may be visualised as a cuboid (or rectangle in 2D), and thus it is very easy to analyse the results of the bundle adjustment.

A large cuboid indicates an unreliable point or projection center, whereas a cuboid inside the error ellipsoid is very satisfactory. Another alternative is to look at the error ellipses of the adjusted object points. The quality check is based on statistically derived criteria for each point and projection center rather than on coarse averages.

Weak areas may also be pinpointed by looking at diagrams showing the area within each image in which the processed data is measured — an image that is not well covered with points is another source of weakness. With these statistical and graphical functions, it is immediately obvious whether the necessary accuracy requirements have been met and where additional investigations are required.

**ORIMA supports the introduction of observed attitude data for each image, in addition to airborne GPS positional data.**



## Product and interaction

- Dynamically link from an **IMAGINE Photogrammetry** project directly into the ORIMA environment for a seamless workflow.
- Enhance imagery in **ERDAS IMAGINE** before bringing it into ORIMA.
- Open or create your photogrammetry project directly in ERDAS IMAGINE with the **IMAGINE Photogrammetry** suite.
- Raster backdrops using the ultra-fast ECW compression format may be directly consumed in ERDAS IMAGINE and **IMAGINE Photogrammetry**.
- Enhance your orthorectified imagery in **ERDAS IMAGINE** before publishing to GeoMedia WebMap.
- Orthorectified images created in this IMAGINE Photogrammetry environment may be published to **ERDAS APOLLO** and delivered over the internet as server-side geoprocesses (WPS).
- Raster backdrops can be streamed, using the ultra-fast ECWP streaming protocol, by **ERDAS APOLLO**.

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Hexagon's Geospatial division creates solutions that deliver a 5D smart digital reality with insight into what was, what is, what could be, what should be, and ultimately, what will be.

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