Solving for Camera Exterior Orientation on Historical Images Using Imagine/LPS

Version 1.0

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The Leica Photogrammetry Suite (LPS) tool in Imagine provides functionality for creating orthorectified images based upon the knowledge of the interior and exterior orientation of the camera during exposure. In systems such as WASP that take advantage of a precision inertial navigation system & utilize metric cameras, the exterior/interior orientation of the camera is already known and no further calculations are required prior to the ortho-resampling process. When the required information is partially or fully unavailable the missing parameters can be calculated by utilizing ground control points and a triangulation process. This tutorial will step the user through calculating the exterior orientation of several historical WASP frames utilizing a pre-existing interior model of the camera and an existing reference ortho of the RIT campus to provide ground control points.

Launch Imagine, currently LPS is only available on the Windows version so this process currently will now work on the CIS Solaris machines. The Imagine tool bar will appear, click on LPS to launch the tool.
Create a new project by selecting “File - > New”
Select the “Digital Camera” model – this assumes that you know something about the existing interior orientation of the camera. WASP’s cameras have always been calibrated for all flights so the interior orientation information is available. Dealing with a non-metric camera is beyond the scope of this tutorial.
The working coordinate system must next be chosen; this value cannot be changed later while working on the project. The exterior orientation x, y, z, omega, phi & kappa calculated for the images imported will be relative to this projection. Here we will choose UTM Zone 18 relative to the WGS84 Ellipsoid.
There are several parameters in the Frame-Specific Information that should be adjusted to aid in the triangulation process. Average Flying Height should be estimated as best as possible to aid the automated tie point algorithm – if unknown it’s not a major problem, just enter a reasonable non-zero value. If preliminary exterior orientation values are available they can be imported, for this exercise we’ll assume we don’t have them. The interior orientation of the camera needs to be loaded next. Press the “New Camera” button.

Press the “Load” button to read the camera calibration file. Interior orientation files for WASP can be found at:

http://twiki.cis.rit.edu/bin/view/LIAS/WaspCameraCalibrations
Image files can now be imported into the project. Select “Edit -> Add Frame” and select the files you wish to calculate the exterior orientation for.
Selecting “Edit -> Frame Editor” allows us to finalize the interior orientation of the camera. Select the “Interior Orientation” tab.

We’re working with WASP VNIR images, each element in that camera is 9 x 9 microns. Select “Apply to all Frames” and press the “OK” button.
We’re now ready to start picking ground control and tie points. Select “Edit -> Point Measurement”

We should now set the horizontal and vertical reference sources utilizing these two buttons:

We’ll be using an existing ortho as our reference for ground control points, select “Image Layer”, navigate to the file and load it. The ortho only provides reference in the x,y direction so a DEM is used for the z reference.

Turn on automatic “z” value updating by selecting this button:
Click on “Use Viewer as Reference” – the left pane will display the base ortho we’re using for reference. We’re now ready to start picking ground control points. Click on the “Add” button then 
. Select a point in the reference frame, click 
 again and select the corresponding point in the right frame.

The point type should now be changed from a tie point to a control point – click on the type and usage fields in the table and select “Full” and “Control” respectively.

Continue the above process and try to get 5 – 10 control points for all frames; points should be spread evenly across the entire image to ensure that no single area of the image is weighted heavier that the other. If working with multiple frames it is advantageous to generate tie points between the frames to aid in the triangulation process. Tie points can either be selected manually or through the automated tie point matching feature. If no initial exterior orientation information is present several manual tie points are required to give the algorithm a starting place.
Pressing the button brings up the triangulation configuration menu. The ground control point standard deviations should be adjusted to represent the accuracy of the points – for the ortho we’re using the points are roughly accurate to 0.5 meters in x, y & z. Further refinement can be had by using surveyed ground control points.

Pressing the “Run” button should yield the following menu stating the residuals calculated while running the triangulation.

Pressing the “Report” Button yields a text file describing various parameters calculated during the adjustment. Half way through the report the calculated exterior orientation of the images is stated as seen below.