

# Orthorectifying Air Photos with GPS data, GCPs and Tie Points



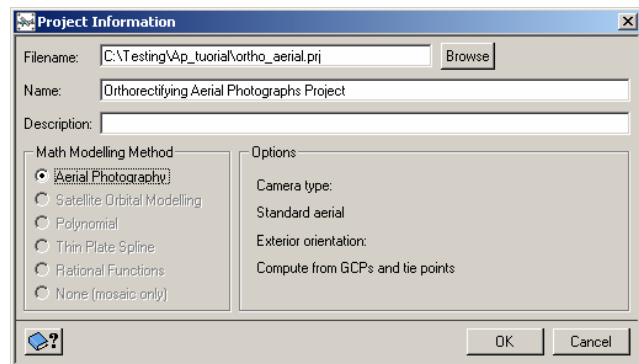
## TUTORIAL

The exterior orientation for air photo projects can be computed with: 1) GPS X, Y, Z data with rotation information (omega, phi, kappa values), 2) GPS data (X, Y, Z) with tie points, or 3) GCPs and tie points. If GPS information is available for each photo, carefully collecting GCPs and tie points can only help improve the model.

Errors in large OrthoEngine projects with multiple flight lines can become difficult to detect once all the photos and control points have been added to a project. The following is therefore a brief tutorial in setting up an Aerial Photography OrthoEngine project with GPS data, GCPs and tie points.

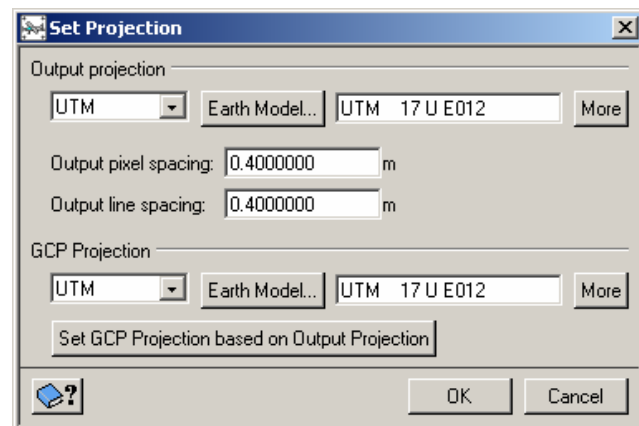
### Step 1:

- Select **File > New** to create a new project in OrthoEngine.
- Enter a Filename and Project Name.
- Select “Aerial Photography” math model.
- Select Camera type - “Standard Aerial” or “Digital / Video” (this example uses Standard Aerial)
- Select **Compute From GCPs & Tie Points** if you have either GPS x/y/z photo centers or x/y/z/omega/phi/kappa data and want to collect GCP’s and Tie Points. Select **User Input** if you have x/y/z/omega/phi/kappa values and will not be collecting any GCP’s or Tie Points.



### Step 2:

- Set the Project Georeferencing and Output Pixel Spacing.



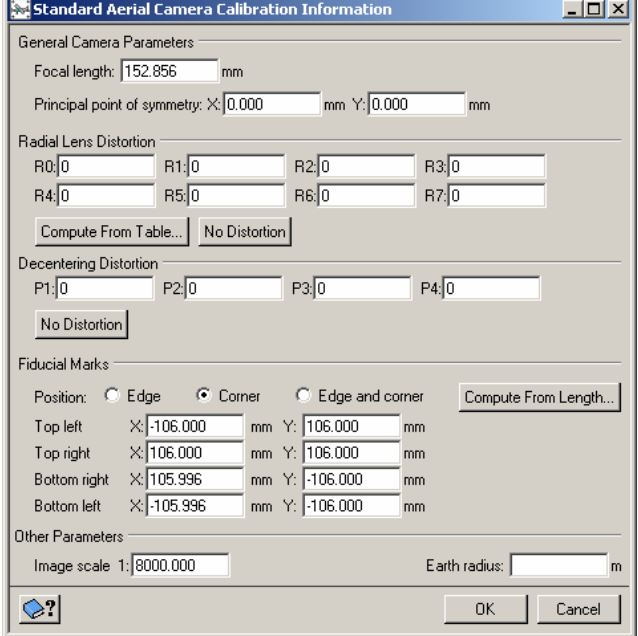
### Step 3:

- Set the camera calibration.

If the camera is a standard aerial, the required information for camera calibration are the camera's focal length and fiducial marks. This information should be provided with your photos, and must be set in the project. All other values on the panel are set to defaults.

If the camera is a digital/video camera, the required information for camera calibration are the camera's focal length and chip information. This information should be provided with your photos, and must be set in the project. All other values on the panel are set to defaults.

See the Help from this window for other parameters.



The dialog box is titled "Standard Aerial Camera Calibration Information". It contains several sections:

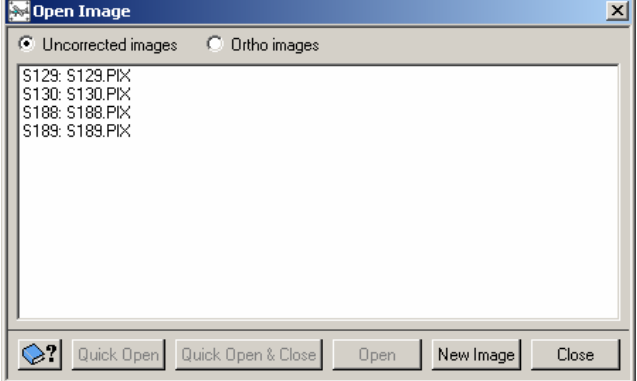
- General Camera Parameters:** Focal length: 152.856 mm; Principal point of symmetry: X: 0.000 mm, Y: 0.000 mm.
- Radial Lens Distortion:** R0: 0, R1: 0, R2: 0, R3: 0, R4: 0, R5: 0, R6: 0, R7: 0. Buttons: "Compute From Table...", "No Distortion".
- Decentering Distortion:** P1: 0, P2: 0, P3: 0, P4: 0. Button: "No Distortion".
- Fiducial Marks:** Position:  Edge,  Corner,  Edge and corner. Button: "Compute From Length...".

Top left	X:	-106.000	mm	Y:	106.000	mm
Top right	X:	106.000	mm	Y:	106.000	mm
Bottom right	X:	105.996	mm	Y:	-106.000	mm
Bottom left	X:	-105.996	mm	Y:	-106.000	mm
- Other Parameters:** Image scale 1: 8000.000; Earth radius: [ ] m.

Buttons: "?", "OK", "Cancel".

### Step 4:

- Select the "Data Input" processing step.
- Select **Open a New or Existing Image**.
- Click on the **New Photo** button.
- For large projects, input one row of photos at a time. This makes it much easier to trouble shoot potential problems within the project if they should arise.
- Click **Quick Open & Close**



The dialog box is titled "Open Image". It has two radio buttons: "Uncorrected images" (selected) and "Ortho images".

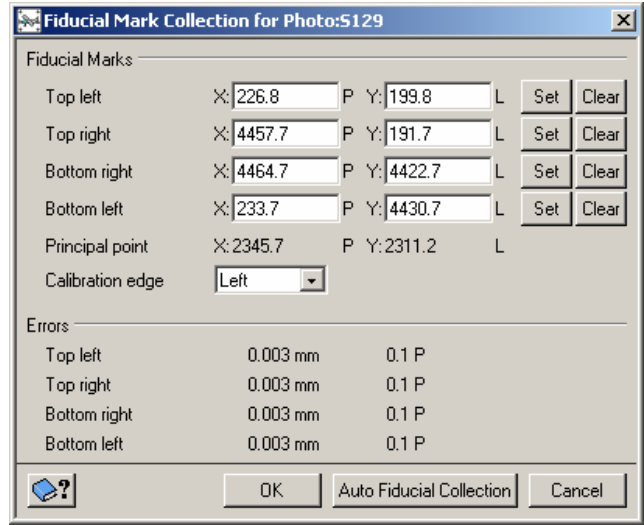
Image list:

- S129: S129.PIX
- S130: S130.PIX
- S188: S188.PIX
- S189: S189.PIX

Buttons: "?", "Quick Open", "Quick Open & Close", "Open", "New Image", "Close".

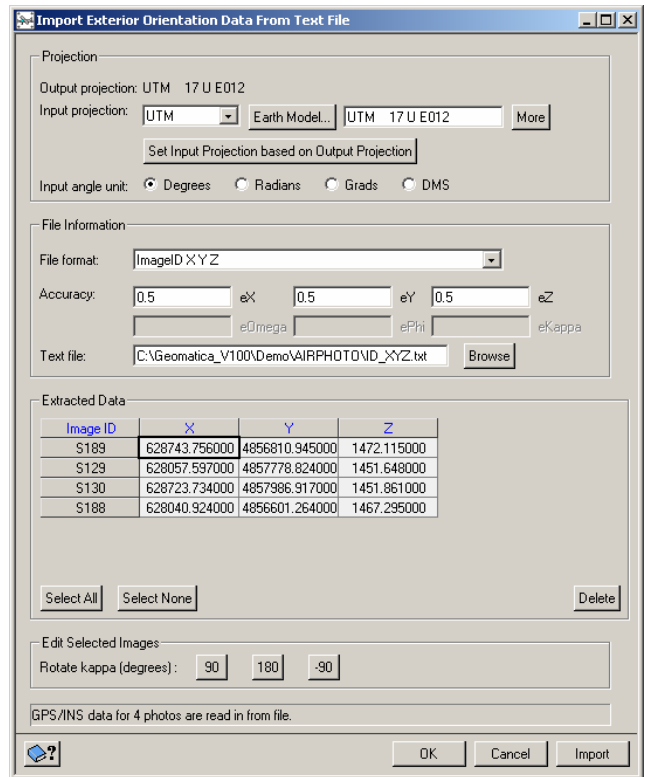
**Step 5:**

- Select **Collect fiducial Info** (if necessary).
- Locate first fiducial (zoom in), and hit **Set**.
- Locate and set remaining fiducials.
- Fiducials for remaining photos can either be manually collected or collected with Auto Fiducial collection.



**Step 6:**

- Select **Import GPS/INS or exterior orientation data from file/manually**. This example shows data from file.
- Select the appropriate **File Format** for your exterior orientation text file. If you do not see a file format that matches your exterior orientation file, you will have to edit it in either a spread sheet or text editor to make it match.
- Input Accuracy
- Enter path and name of exterior orientation file.
- Click **Apply**



**Step 7:**

- Select the **GCP/TP Collection** Processing step.
- Open at least two photos and collect tie points. If you have georeferenced vectors, images, or the coordinates for known locations, also collect GCPs.
- If you selected **User Input** as Exterior Orientation in Step 1, you do not need to collect any GCP or Tie Points.

**Tie Point Collection**

Tie point ID: T0002

Elevation: +/- m

Auto locate  Compute model

Working Image Tie Point

S129 4172.8 +/- P  
3078.8 +/- L

Reference Image Tie Points

Image ID	Pixels	Lines
S189	3198.8	334.7
S130	2467.8	3078.7

Quick Open Image

Accept Delete Clear New Point

Accepted Tie Points: 7 Total

Residual units:  Ground  Pixels  Microns

Point ID	Residual	Res X	Res Y	Type	Image
T0001	0.239	0.03	-0.24	TP	3449
AT0012	0.212	-0.01	0.21	TP	2333
AT0011	0.137	-0.12	-0.07	TP	4303
AT0009	0.130	0.04	-0.12	TP	2353
AT0010	0.124	0.08	-0.10	TP	2270
T0002	0.086	-0.08	0.02	TP	4172
AT0013	0.041	-0.04	0.01	TP	4081

Auxiliary Information

Select DEM:

Close

**GCP Collection for S129**

Ground control source: Text file

Select Text File...

DEM: AP\_DEM.PIX Browse

Auto locate  Compute model

Working Image: S129

Point Projection: UTM 17 U E012

Point ID: G0011 GCP

Image pixel: 319.6 +/- 0.1 P

Image line: 2256.9 +/- 0.1 L

Easting (X): 627263.380 +/- 1.000 m

Northing (Y): 4857514.540 +/- 1.000 m

Elevation (Z): 213.400 +/- 1.000 m

Accept Delete New Point Extract Elevation

Reference Images

Image ID	Status

Open Image

Accepted Points: 6 Total

Residual units:  Ground  Pixels  Microns

RMS: 0.39 X RMS: 0.26 Y RMS: 0.29

Point ID	Residual	Res X	Res Y	Type	Image
G0011	0.32	-0.25	0.20	GCP	
G0012	0.52	0.22	-0.47	GCP	
G0013	0.41	0.29	-0.30	GCP	
G0014	0.34	-0.25	0.22	GCP	
G0015	0.23	0.22	-0.05	GCP	
G0016	0.25	0.20	0.16	GCP	

Close

### Step 8:

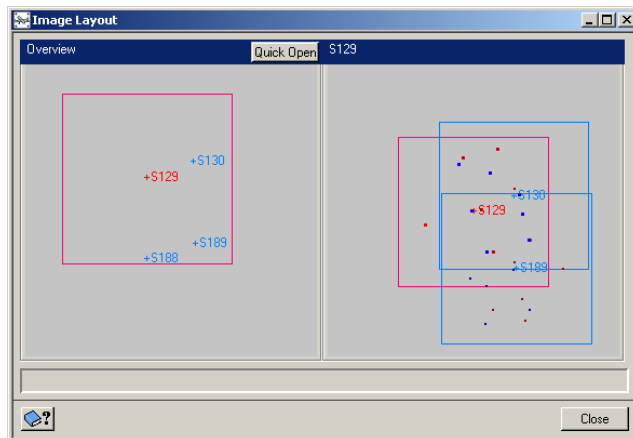
- Select the **Model Calculations** Processing step.
- Click the **Perform Bundle Adjustment** button.

### Step 9:

- Check the quality of tie points and GCPs collected. This can be done in the GCP or TP Collection Panel or in the Residual Reports Panel in the Reports Processing step.

### Step 10

- Select the **GCP/TP Collection** Processing step. **Display overall Photo Layout** will allow you to see if the tie points/GCPs you have collected are well spread out.



Point ID	Res	Res X	Res Y	Type	Image ID	Group
G0019	0.738	-0.133	-0.726	GCP	S189	628
G0020	0.719	0.382	-0.609	GCP	S188	628
G0024	0.636	-0.575	-0.272	GCP	S189	629
G0012	0.623	-0.333	-0.526	GCP	S130	627
G0012	0.518	0.215	-0.471	GCP	S129	627
G0016	0.468	-0.450	-0.128	GCP	S188	628
G0016	0.463	0.308	0.346	GCP	S130	628

### Step 11:

- Select the **"Data Input"** processing step.
- Select **Open a New or Existing Image**.
- Click the **New Photo** button.
- Add an adjacent flight strip of photos to the project.
- Perform steps 5 to 9 for this row of photos. For step 7, be sure to collect TPs between rows and columns of photos.
- Continue adding rows of photos and performing steps 5 to 9 until all photos have been added to project.

### **Things to double-check if unable to update bundle or obtain photo layout**

- Values for Camera Calibration
- Value for Earth radius. In the Help, it says "Earth radius correction is only needed for photos over 1:20000 scale."
- Ensure every photo ID is associated with a GPS coordinate in the corresponding GPS text file.
- After adding photos to the project, make sure to update the GPS/INS input so the exterior orientation can be calculated.
- Check the quality and quantity of GCPs/TPs collected.

**The following data affects the bundle adjustment. Any change to this information indicates that the currently computed exterior orientations may be out of date (i.e., stale).**

- Addition or removal of project photos
- Changes to camera focal length
- Changes to Earth radius
- Changes to active GCP positioning
- Changes to TP positioning