Australis Version 6.03

Preliminary Guidelines for the Use of the Network Simulator

1. Introduction

The simulator functions basically as follows:

a. A set of object point XYZ coordinates is input (file extension .xyz). This may or may not include target size information and target normal components. The normals (nX, nY, nZ) can be used to determine target visibility.

b. A preliminary camera station configuration is read (file extension .eof), with the exterior orientation being input as either XC,YC,ZC,Az,El,Roll or XC,YC,ZC,Xa,Ya,Za where Xa,Ya,Za indicates the coordinates of the aim point. **Note:** The prior input of camera station information is optional as this can be interactively generated if desired.

c. The camera station positions & orientations can then be varied interactively (and initiated interactively if required).

d. Once the network is as desired, a 1-iteration bundle adjustment is performed to compute the network precision. Standard errors and covariance matrices are output and 3D error ellipsoids are displayed within the graphics view.

2. Operational Procedure

2.1 Prepare the object point file

The object point file (which should have an extension of **.xyz**) can take one of 4 forms:

4 columns - point name, X, Y, Z
7 columns - point name, X, Y, Z, sX, sY, sZ
8 columns - point name, X, Y, Z, r, nX, nY,nZ
11 columns - point name, X, Y, Z, sX, sY, sZ, r, nX, nY, nZ

Here, ‘point name’ is the usual *Australis* point label (alphanumeric); X,Y,Z are the object point coordinates; sX, sY, sZ are the assigned standard errors (not needed if a free-network adjustment will be performed; defaults apply when sigmas are not listed); r is the target radius in project units (not needed for the simulation, however appropriate values will support the 3D view of the object points); and nX, nY, nZ are the components of the normal vector to the target plane (can be given an arbitrary length), which determine target visibility from a given direction.

An example file with 7 columns is listed below (note space or tab delimited):

P00_0	-0.0	-0.0	-0.0	0.015	0.015	0.023	10.0	0.00	0.00	1.00
P00_1	140.0	0.0	8.0	0.016	0.015	0.022	10.0	-0.11	0.00	0.99
P00_2	280.0	0.0	32.0	0.018	0.016	0.023	10.0	-0.22	0.00	0.97
P00_3	420.0	-0.0	72.0	0.017	0.016	0.021	10.0	-0.32	0.00	0.94
P01_2	263.1	95.8	32.0	0.017	0.016	0.022	10.0	-0.20	-0.07	0.97

… Etc.

2.2 Prepare the camera station file (only where 'batch' entry is required))

The camera station file, which must take the extension '.eof' (eg *stations.eof*) can be in one of two forms:

i) Station name, X, Y, Z, Az, El, Roll (in radians) [, resected flag [, path to image coordinate file (*if available*)]]

ii) Station name, X, Y, Z, XA, YA, ZA, Roll [, resected flag [, path to image coordinate file]]

Here, XA,YA,ZA represents the aim point within the object point field. Angles are entered in degrees. Note that arguments between the []-brackets are optional & not important for the basic simulation function. Note that format (i) is always used when EO data is exported from Australis.

A sample camera station file with the structure X, Y, Z, Az, El, Roll is listed below:

```
// Australis Camera Station File for Simulation
//
// image      X      Y     Z    azimuth  elev. roll resected(flag)
//
Image001  1500.  1500.  1500.  136.8  -33.2    9.  1
Image002  1500.   500.  1500.  108.8  -41.8   21.  1
Image003  1500.  -500.  1500.   71.6  -41.8  -28.  1
Image004  1500. -1500.  1500.   45.8  -31.5   19.  1
Image005 -1500.  1500.  1500. -134.6  -31.5   29.  1
Image006 -1500.   500.  1500. -106.5  -41.8   15.  1
Image007 -1500.  -500.  1500.  -71.6  -41.8   26.  1
Image008 -1500. -1500.  1500.  -43.0  -35.8  -25.  1
```

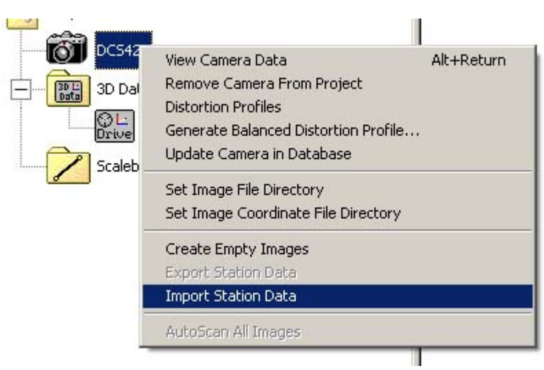
2.3 Initiate the Australis run

At this point, *Australis* can be commenced in the usual way:

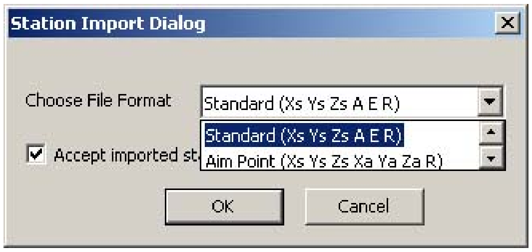
i) A new project is selected & units defined
ii) The camera is assigned
iii) The project is saved & the project name established
iv) The simulated *ObjectPoints.xyz* file (2.1 above) is imported as a Driveback file

2.4 Importing the camera station information

To import the *CameraStations.eof* file, right click on the project camera icon and select **Import Station Data.**



At this point you will be asked to select the format for the *CameraStations.eof* file from two options, as described in 2.2 above.

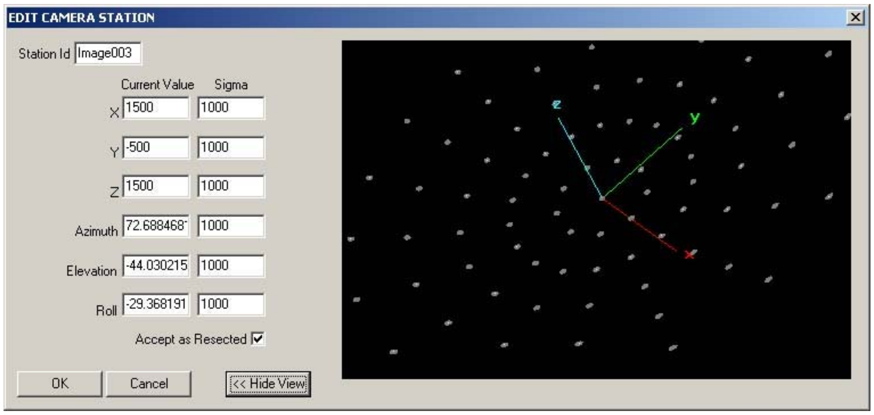


Once OK is selected, all camera stations are imported, giving rise to fictitious images which are listed in the normal way. Note, however, that at this point there are no image coordinates associated with these images.

Note: As will be described in 2.7, all camera station information can alternatively be generated interactively via the 3D object point viewer.

2.5 Viewing/adjusting the simulated image

By either right clicking on an image icon & selecting **Edit Exterior Orientation** or by highlighting the image & typing **Alt+Enter**, the following dialog is displayed:



The simulated view of the **driver** object point field is turned on or off using the **Show View/Hide View** button

At this point the operator can change the exterior orientation of the image, as follows:

i) Highlight an object point (left mouse button) and use the context menu (right click in view widow) to make the selected point the new aim point for the current camera station (note that the Az, El & Roll values change).

ii) Moving the mouse while pressing the right mouse button changes the rotation (pointing adirection) of the camera station (note that all angle values change).

iii) By holding down the CTRL key & the right mouse button, the image can be rotated around the viewing axis (note that the Roll value changes).

iv) By holding down the SHIFT key & the right mouse button, the image station coordinates are panned parallel to the image plane (note that the X, Y and Z values change).

v) The image can be zoomed in or out along its viewing axis by using the UP/DOWN keyboard arrows or the mouse wheel (note that the X,Y,Z values change)

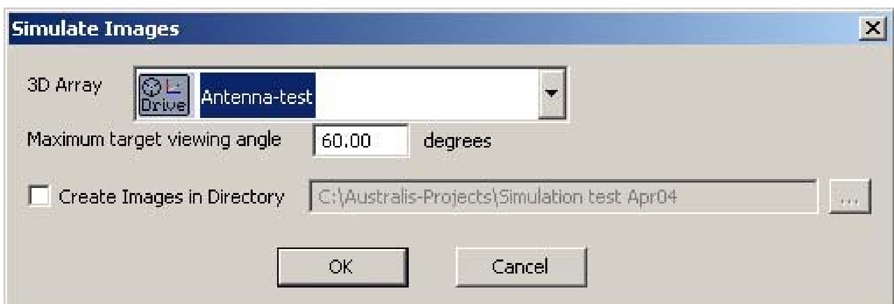
CAUTIONARY NOTE: On some Windows installations, the use of the mouse wheel for zooming in this view causes the program to abort – we are trying to track down the cause of this problem, which has only appeared on two Notebook PCs to date (CSF, 14 April 2004)

vi) Values of any of the exterior orientation parameters can be changed.

Note also that you can generate additional simulated images, as will be explained in Section 2.7.

2.6 Generating the image coordinates for the simulated images

The next step is to generate the image coordinates for each of the specified images. This is accomplished by selecting **Simulate Images** from the main **Measurement Menu**. The following dialog will then appear:



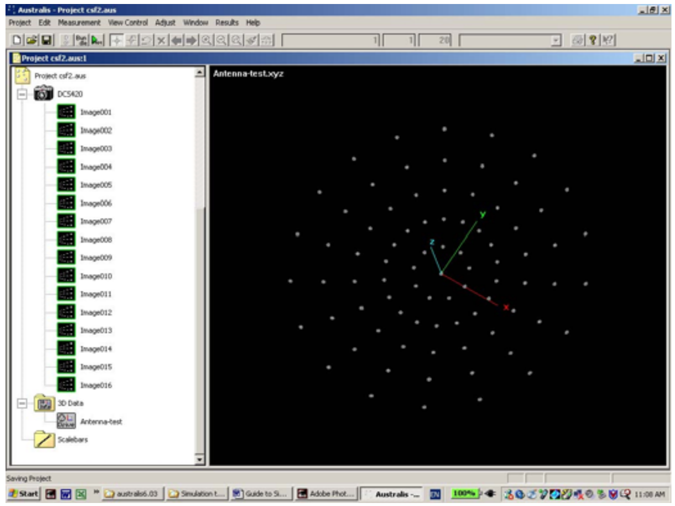
In most cases you will simply need to select OK and image coordinates will be created for each image in the tree. If needed, simulated image files (tiffs) can be exported to a chosen folder.

2.7 Deleting image point observations

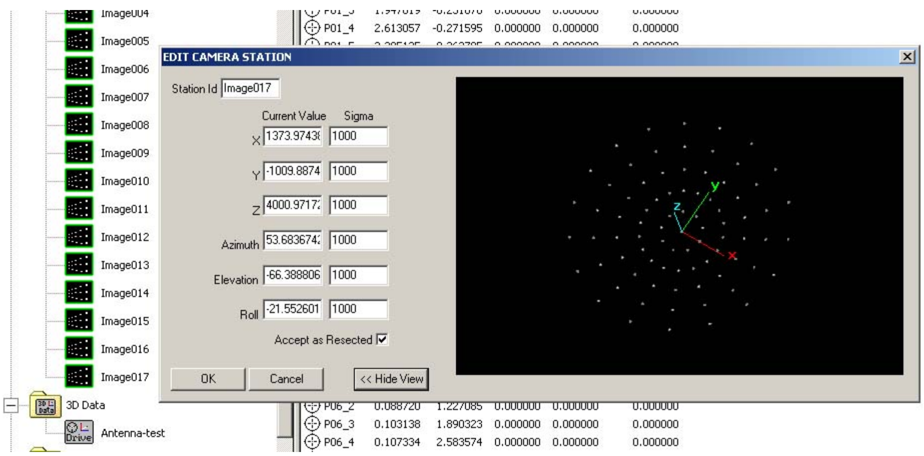
Once the simulated image coordinates have been generated, selected points can be deleted either from the image coordinate lists (single click on image icon & then highlight point(s) to be deleted) or from the graphical view of the image coordinate locations (double-click on image icon & the highlight and delete point(s) in the normal manner).

2.8 Adding further simulated images

A very flexible feature of the *Australis Simulator* is the ability to add simulated images from the 3D object point graphics view. Imagine that you have the 3D Viewer open as follows:



Further imagine that you wish this viewpoint to represent a simulated image. In order to generate the image simply Right Click in the 3D view & select **Create Image** or simply select **CTRL+I**. You will note that an additional image is then added to the tree. Its EO information in this case is as follows:



Variation to the exterior orientation of the image can then be effected via the options listed in 2.5.

Note also, that you can rotate the 3D view (CTRL+right mouse button) before ‘recording’ the simulated image. Thus, you can vary the roll angles; roll angle variation is quite critical for self-calibration.

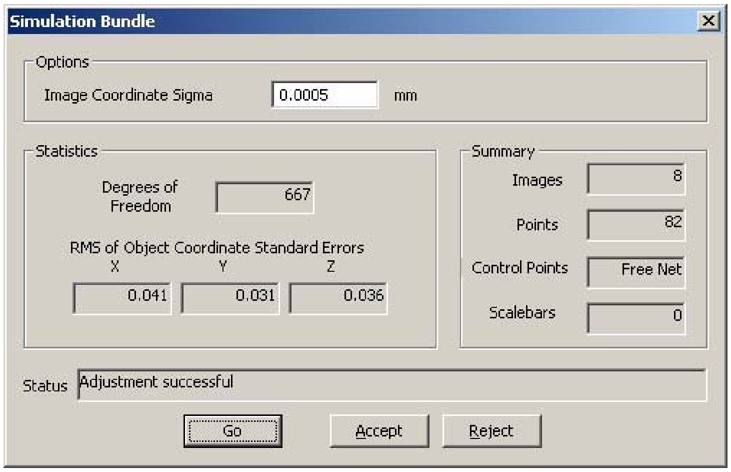
Another feature here is the selection of a specific aim point. Within the 3D view, highlight a point and then select **SHIFT+CTRL+I.** This will generate a new image, with the selected aim point being at the centre of the image. If the project contains multiple cameras a small dialog comes up (after taking the image) to select the corresponding camera.

In summary, you can build up a network interactively using this approach; it is then not necessary to specify and import any camera station positional data.

2.8 Running the bundle adjustment (Simulation Bundle)

Before running the bundle adjustment for the simulated network, it might be wise to run a final **Measurement/Simulate Images** in order to ensure image coordinates reflect latest changes in exterior orientation. Also, you might for reassurance wish to run an **Adjust/Resect all Images** in order to verify that you have enough points in each image (the residuals will be zero). If for some reason you have not elected to **Accept as Resected** (Sect 2.5) all images, then an explicit resection would be required.

In order to run the Bundle Adjustment for the simulated network, select **Simulation Bundle** from the main **Adjust Menu**. The following dialog will then appear:



The only variable to consider here is the assigned initial standard error value of image coordinates. Note that the units are Millimetres. Typically for digital photogrammetry, appropriate values will vary from 0.0003 mm for automatic centroiding (eg 1/30th pixel for 9 µm pixel size) to, say, 0.003 mm for good quality manual pointing (eg 0.5 pixel accuracy for 7 µm sized pixels). Because the final object point standard errors are a straight linear function of the image coordinate sigma, it is important to assign an appropriate value here.

Selecting GO will initiate a one-iteration bundle adjustment which will generate the usual output files, along with the overall results summary shown above.

Cautionary Note: Do not select the normal bundle adjustment option here, for although you will get a result, you'll find that all output sigma values will be zero. You must select **Simulation Bundle.**

2.9 Object point covariance matrices & error ellipsoids

In order to generate the 3x3 covariance matrices associated with each triangulated object point, it is necessary to select this output option prior to running the Simulation Bundle adjustment. Simply select **Project/Preferences/Output/Covariance Matrices of 3D points**. A file *PointsQxx.txt* will then be generated within the project folder.

The individual covariance matrices are used to generate error ellipsoids which indicate the precision of each point. This is particularly useful for ascertaining the relative distribution of precision within the object point array. After the Simulation Bundle run, open the 3D view by double-clicking on the Bundle icon in the 3D data list. Then select CTRL+E to display the ellipsoids. The display scale can be varied by right clicking within the view window & then selecting to either increase or decrease the display scale of the error ellipsoids, as indicated in the figure below.