Objectives

1. To perform a geometric correction with Ground Control Points (GCPs)
2. To quickly compare the resulting geocorrected image with the results of a parametric approach

Lesson outline

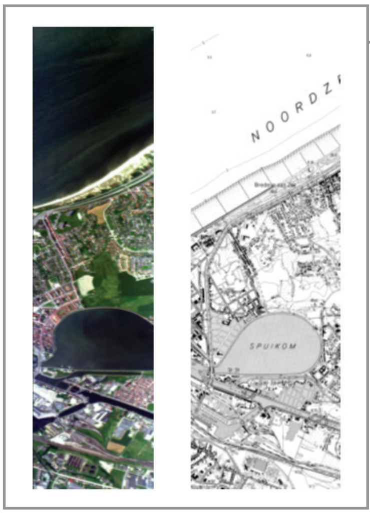
Hands-on computer exercises

Objective

In this exercise you will georeference a hyperspectral Compact Airborne Spectrographic Imager (CASI) image to a topographic map of the same area. The topographic map will be used as the basis to correct the CASI image.

Image data

The CASI data were obtained in June 2003 in the framework of the BELCOLOUR project (http://www.mumm.ac.be/BELCOUR/). The topographic map dates from the period 1978- 1993 (Figure 1.4). The area covered in the data is Bredene-aan-Zee, Oostende, Belgium. The CASI sensor was installed in a Dornier 228 aircraft. The aircraft and CASI sensor were operated by NERC (Natural Environment Research Council), UK. The CASI was flown at an altitude of 2000 m, providing a spatial resolution of 4 m. The spectral configuration of the CASI was 96 channels from 405 to 947 nm with a FWHM of 6 nm.



>> Fig.1.4 : (Left) uncorrected CASI image and (Right) topographic map.

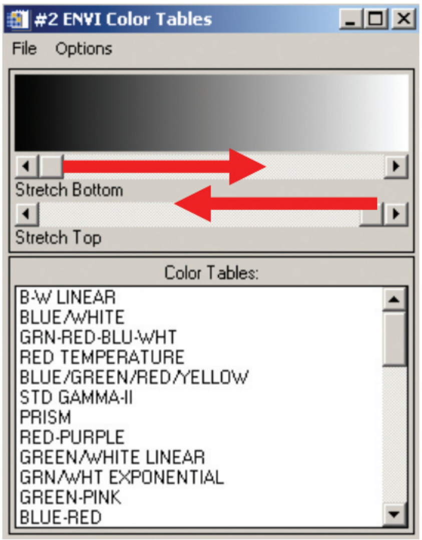
1. Open and display the CASI image and the topographic map

Action : In the ENVI < main menu> use the <Open Image File> option to open the uncorrected CASI image (Uncorrected) and display a true colour image (display #1).

Action : In the ENVI <main menu> use the <Open Image File> option to open the topographic map (TOPO.TIF) and load band 1 as a greyscale image into a new display window (# 2).

Action : Change the colours of the topographic map to have a nicer view (white background and black foreground)

> **Hint** : In the Main Image display select <tools> <color mapping> <ENVI color table>. Move the Stretch Bottom slider to the right and Stretch Top slider to the left.



2. Beginning the georeferencing

Action : Select <Map> <Registration> , <Select GCPs : Image-to-Image>. When the <image to image registration> dialog appears, click on <Display # 2> (Topographic map) for the Base image (= image you use as reference, so already georeferenced) and on <Display # 1> (CASI image) for the Warp image (=uncorrected image)) .

Now you can start with collecting GCPs.

Question 1.6 : What is your definition of a set of ideal Ground Control Points? Can you fulfil in this case all the requirements? What is the problem?

Action : Add individual GCPs by positioning the cursor position in the two images on the same location : In the <Main Image> window of each image, position the <Zoom box> over the desired GCP area. In the zoom window, click the left mouse button on a specific pixel to position the cursor over that pixel. Once you think you have positioned your cursor as close as possible to the same point on each image click on <Add Point> in the <Ground Control Points Selection> dialog. The pixel information is loaded into the Ground Points Selection dialog. The GCP marker is placed showing the position in the zoom window. You should periodically save your results : In the <Ground Control Points Selection> dialog select <File> <Save GCPs to ASCII> and enter an output filename with the .pts extension.

Hint : Zooming in as far as possible is not always the best strategy. Just zoom in far enough so that you can accurately position the cursor in each image.

Once you have at least 5 GCPs (this is sufficient to conduct a 1^{st} degree polynomial warp), you will see that a total RMS (Root Mean Square) error is reported in the Ground Control Points Selection dialog. The RMS error for each point is also listed in the GCP List table. This error is calculated by applying a transformation across the image using the other points you have selected (hint : click on <show list>). The residual is the difference between the predicted location and the position of this point according to the reference map. The higher the RMS the further the point is away from where the transformation predicts it to be, based on the other points. The degree of polynomial used for calculating the error is displayed in the <Degree box> in the Selection dialog and can be changed when a sufficient number of GCPs has been selected.

Action : When you have a reasonable number (10 – 15) of ground control points you can start to produce a geocorrected version of the originally uncorrected image. Instead of georeferencing all 96 bands we will perform the georeferencing on only 1 band in order to reduce the computing time. In the <Ground Control Points Selection> dialog select <options>, <Warp Displayed Band (as image to map)>. Select as <Warp method> <polynomial> and as <degree> <1>. As <resampling> method we choose <nearest neighbour>. Click on <change output parameters> and change the <X, Y pixel size> into 4 meters.

Enter an output filename (corrected_pol_1) for your image.

Action : Repeat previous step but use as warping method a 2^{nd} order polynomial. Save as <corrected_pol_2>.

Action : Repeat using this time <RST> which stands for (Rotation, Scaling, and Translation) as warping method.

Save as <corrected_RST>.

Action : First close the <Ground Control Points Selection> dialog and also the uncorrected CASI image.

The georeferenced bands (corrected_pol_1, .._pol_2, .._RST) should appear in the <Available Bands List>. Now you can start comparing your results with the topographic map.
Before you start, let's have a look at the results of a parametric approach. You can find this image with filename <geocorrected_parge> in your image directory. This image has been corrected with the geocoding software PARGE using attitude (roll, pitch, yaw) and position information (latitude, longitude, altitude) of the sensor measured during the flight.

Action : Open the <geocorrected_parge> file and display a true color image.

Action : Load the different georeferenced bands in new display windows. Now you can link all images on the basis of their geographic coordinates. In the Main Image Display of the topographic map select <Tools>, <Link>, <Geographic Link> and click on the arrow buttons to select <On> next to the display names. Now watch roads, shorelines, bridges,…. to check if they line up accurately.

Question 1.7 : Which image (corrected_pol_1 or .._pol_2 or .._RST geocorrected_parge) is positioned best? Why it is difficult to accurately georeference an airborne image using only GCPs data ?

Answers to questions

Answer 1.6 : What is your definition of a set of ideal Ground Control points? Can you fulfil in this case all the requirements ? What is the problem?

GCPs are points that should be perfectly identifiable on both the reference map and the CASI image and that are unlikely to change over time (such as road intersections, land/water points, buildings,…). It is important to distribute the GCPs evenly across the image. Some points should be selected close to the edges, other more in the middle. In case you position your points all in one part of the image that area will be corrected quite good, but the remainder may be distorted.

The problem with this image is that we can't distribute the GCPs throughout the scene since in the sea part of the image no GCPs can be identified. Furthermore the reference topographic map is far older than the image and several roads were not yet present in the topographic map.

Answer 1.7 : Which image (corrected_pol_1 or .._pol_2 or .._RST geocorrected_parge) is positioned best ? Why it is difficult to accurately georeference an airborne image using only GCPs data ?

The image corrected with the parametric geocoding software (PARGE) has the best positional accuracy. In case the geocorrection is based on only GCPs no information is used about the sensor position and attitude (roll, pitch movement of aircraft) and it doesn't take into account distortions caused by the terrain relief. This can result in low-fitting accuracy because of the local character of the distortions. You can clearly see in the geocorrected_parge image that the aircraft has made some roll movements during the data acquisition. The Parametric approach uses this information during geometric correction.