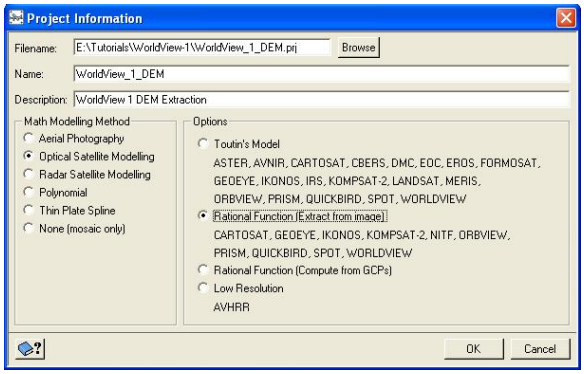
Geomatica OrthoEngine v10.2 Tutorial
DEM Extraction of WorldView-1 Data

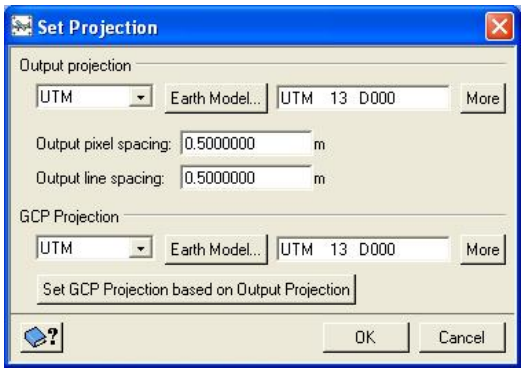
WorldView–1, launched on September 18, 2007, offers a panchromatic imagery at a very high resolution of 50 cm at nadir. The key benefits of this highly detailed imagery are in the sectors of precise map creation, change detection and in-depth image analysis. Data is distributed by DigitalGlobe (www.digitalglobe.com).

The following is a brief tutorial over the use of Geomatica OrthoEngine v10.2 for extracting DEM from WorldView -1 raw (Basic) imagery with Rational Polynomial Coefficients (RPC).

1.0 Initial Project Setup

Start OrthoEngine and click '*New*' on the File menu to start a new project. Give your project a '*Filename*', '*Name*' and '*Description*'. Select '*Optical Satellite Modeling*' as the Math Modeling Method. Under Options, select '*Rational Functions*'. After accepting this panel you will be prompted to set up the projection information for the output files, the output pixel spacing, and the projection information of GCPs. Enter the appropriate projection information for your project.

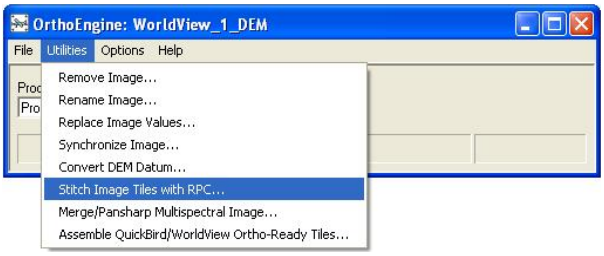


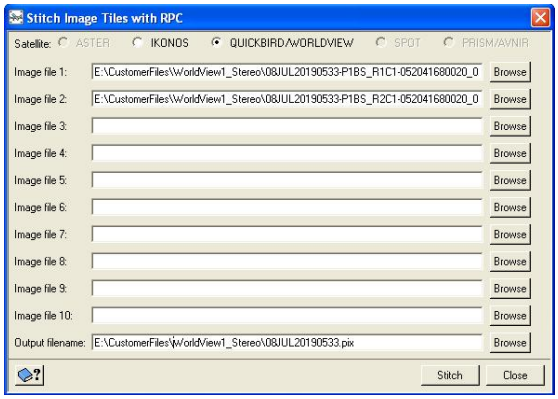


2.0 Stitch Images

WorldView-1 data is delivered in *Geotiff 1.0, NITF 2.0, and NITF 2.1* formats, which are fully supported by Geomatica OrthoEngine v10.2. The data is also delivered with a number of support files (*ATT, EPH, GEO, IMD, RPB, STE, TIL and XML*). Please note that these support files should be located in the same directory as the image data while reading the data. Depending upon your media delivery method, you may have to copy or extract your data to your hard disk.

Stitch the image tiles that contain R1C1 and R2C1 by '*Stitch Image Tiles with RPC*' under '*Utilities*' menu. Stitch combines different RPC files in to a single RPC for the entire stitched image. The image will get converted into .PIX format.





After the successful completion, software will prompt to add the stitched image to the project. Select *OK* to continue with the project.

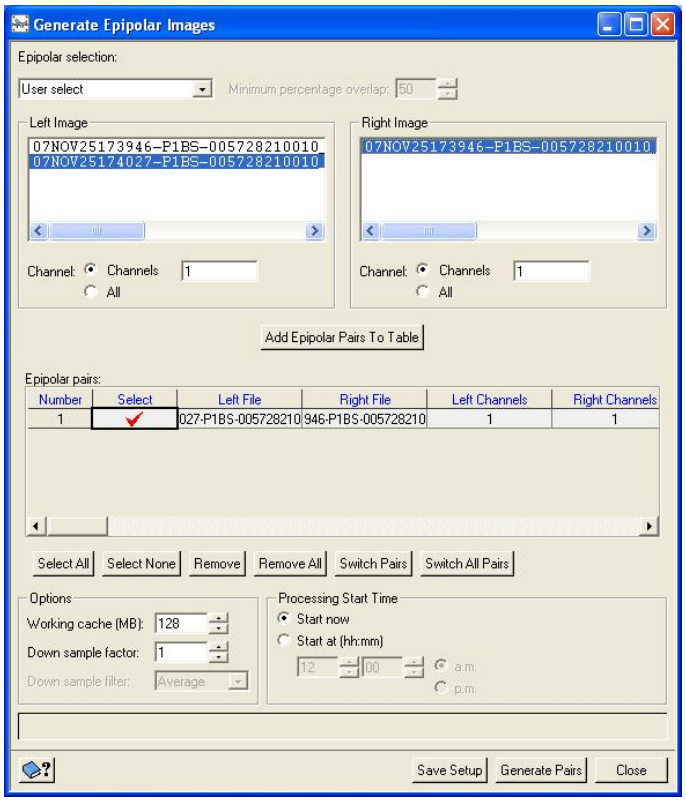
The stereopair of the Worldview-1 might be delivered in separate tiles as well. In that case, stitch the stereoimage and add it to the project as well. Otherwise, add .TIFF file to the project and continue to the next step. The project would then consist of two files (two .PIX files if stereoimages were stitched and added to the project; one .TIFF file and the other .PIX file if only the main image were in tiles).

3.0 Collect GCPs and Tie Points

At this point you can proceed right to the *DEM From Stereo* processing step if you do not have GCPs. The model will be computed based on the supplied RPCs. If you do have a few GCPs, you can proceed to the GCP collection stage to add these to your project. The model will be updated automatically, and you can review these GCPs in the residual report panel.

4.0 DEM from Stereo: Generate Epipolar Images

When '*User Select*' is chosen as '*Epipolar selection*', selection of exact left and right image does not matter. Just select any image as '*Left Image*' and other image will be added as the right image. Make sure to select the image under '*Right Image*' box and click on '*Add Epipolar Pairs to Table*' to record the pair(s) under List of '*Epipolar Pairs*'. If '*User Select*' is chosen, repeat the steps until all stereopairs are recorded. In '*Down Sample Factor*' put the number of image pixels and lines required to calculate one epipolar image pixel.



In '*Down sample filter*', click the method used to determine the value of the epipolar image pixel when the Down Sample Factor is greater than 1.
Select one of the following:

- '*Average*' to assign the average image pixel value to the epipolar image pixel. The average is obtained by adding the image pixel values that will become one epipolar image pixel and dividing that value by the number of image pixels used in the sum.
- '*Median*' to assign the median value of the image pixels to the epipolar image pixel. The median is obtained by ranking the image pixels that will become one epipolar image pixel according to brightness. The median is the middle value of those image pixels, which is then assigned to the epipolar image pixel.
- '*Mode*' to assign the mode value of the image pixels to the epipolar pixel. The mode is the image pixel value that occurs the most frequently among the image pixels that will become one epipolar image pixel.

Check off the epipolar pairs under the '*Select*' column and then click on '*Generate Pairs*'.

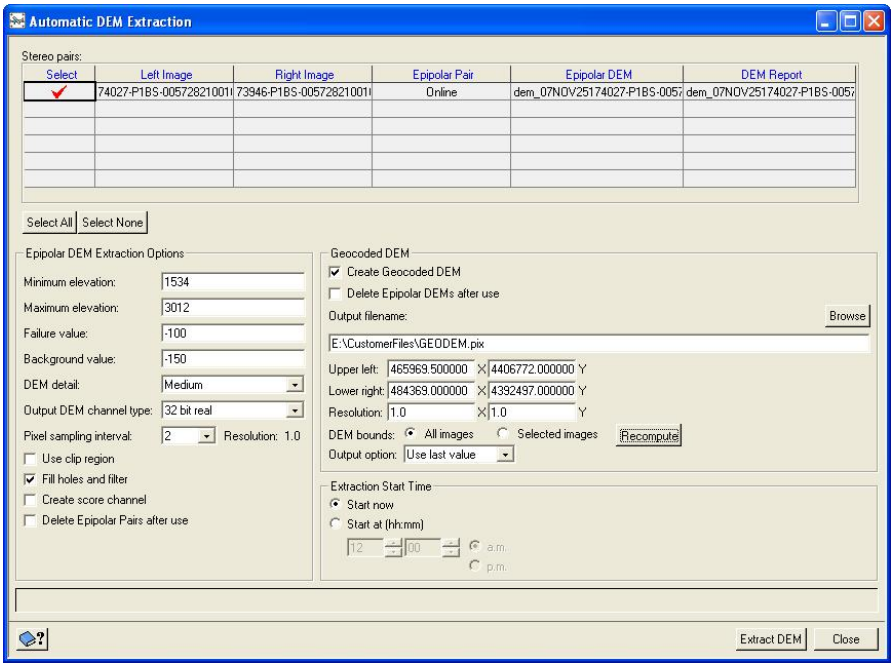
5.0 Extract DEM

Under the DEM from Stereo processing step, select '*Extract DEM Automatically*' button.

- In '*Select*' column, check off the epipolar pair from which the DEM will be extracted
- Under the '*Epipolar DEM Extraction Options*':
    - Enter '*Minimum*' and '*Maximum*' elevation values. This elevation range is used to estimate the search area for the correlation. This would increase the speed of the correlation and reduce errors.

- If the resulting DEM contains failed areas on peaks or valleys, then try increasing the range.
- For '*Failure*' value, enter the value used to represent the failed pixels in the output DEM. The default is set to be -100
- Enter a '*Background value*' to represent "No Data" pixels that lie outside the DEM. These pixels are distinguished so that they would not be mistaken for elevation values. The default value is -150.
- For '*DEM Detail*', specify the level of detail desired for the output DEM. Low detail indicates that the process stops during the coarse correlation phase of aggregated pixels. High detail would mean that the process continues until correlation is performed on images at full resolution.
- In the '*Output DEM channel type*', enter 32 bit real.
- Select the desired '*Pixel Sampling Interval*', or sampling frequency. This parameter controls the size of the pixel in the output DEM relative to the input images. The higher the number specified, the larger the DEM pixel will be and the faster the DEM is processed.

- Under the '*Geocoded DEM*" section, select '*Create Geocoded DEM*' to geocode and merge the epipolar DEMs. However if the DEM is to be edited prior to geocoding, leave this option unselected. If the option is selected, enter a file name for output DEM.
- Click on '*Extract DEM*' button.



6.0 Edit DEM

The generated DEM may contain pixels and/or areas of failed or incorrect values. It is possible to edit the DEM to smooth out the irregularities and create a more pleasing output.

The tool to edit DEMs can be accessed in '*OrthoEngine* | *DEM from Stereo* | *Manually Edit Generated DEM*'. On this button click, Focus will pop-up and the DEM Editing panel will be displayed.

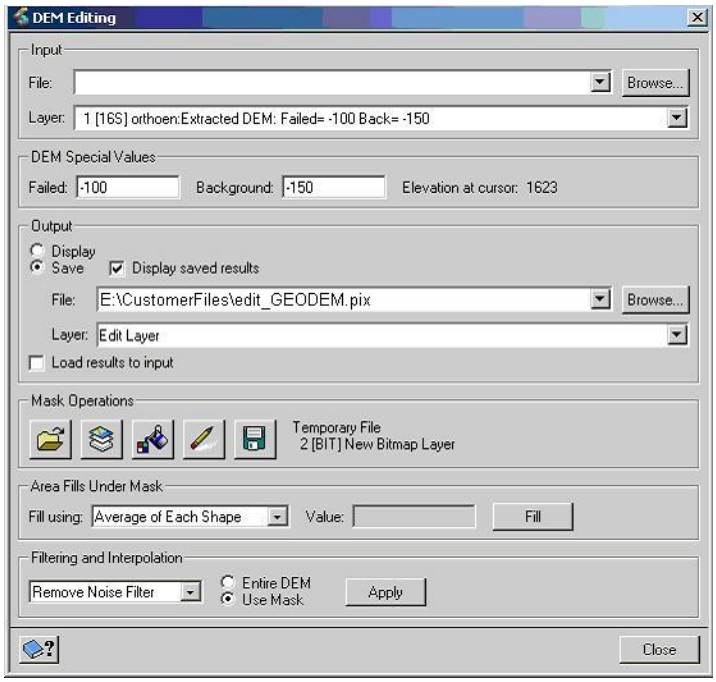
In the DEM Editing panel:

- For '*Input*', browse to the DEM that was created from DEM Extraction step and select the layer that contains the DEM.
- Under '*DEM Special Values*', enter the failed and background values of the DEM.

- As '*Output*', select '*Save*' and specify an output file name. Enter in a layer name as well. Enable '*Load results to input*' if edits are to be done repeatedly to achieve a cumulative effect on the data. Click on 'Display saved results'.
- '*Masks*' can be used to identify areas that are to be edited. Area fills, filtering and interpolation will be performed to the area under the mask.

In the Mask Operations section of the panel, click on the 'New Mask Layer' button. Then click on the 'Mask Failed Pixels' button to generate a bitmap mask over pixels that have the DN value of failed areas.

Pixel values under the mask can be replaced with a specified value or average based on other shapes. To replace values, select the method under 'Fill using' and then click Fill. Filters can also be used to eliminate failed or incorrect values. Filters can be applied repeatedly or in different combinations for a cumulative effect. It is also possible to filter areas under masks. To apply a filter, specify the desired method under 'Filtering and Interpolation'. Select the area to be filtered (entire DEM or area under mask) and click '*Apply*'.



7.0 Examine Results

Examine the DEM in Focus and continue editing if necessary.

Bad results in the DEM can often be caused by the data, the stereo coverage, the accuracy of the model generated from control points, etc. If there are numerous failed areas that cannot be easily corrected using the DEM Editing Tools, then try returning to OrthoEngine and generating epipolar images again or extracting DEM using different parameters (e.g. increase the down scale factor). The PCI Geomatica help files on Applying Tool Strategies for Common Situations in Digital Elevation Models contain more information about improving DEM output.