Batch Automatic Image Georeferencing

The Auto-Register to Reference process (Image / Auto-Register to Reference) allows you to automatically georeference any number of satellite or aerial camera images by auto-registering them to one or more reference images. The input images must have minimal approximate georeferencing to start with (such as nominal position information supplied with satellite images) or be geolocated by GPS coordinates stored in EXIF camera metadata or an auxiliary metadata file. Lens distortion in aerial camera images should be removed in the Lens Correction process (Image / Resample and Reproject / Lens Correction) before using them in the Auto-Register to Reference process.

If you select multiple reference images, the process automatically assigns a reference image to each input image based on their spatial locations and extents.
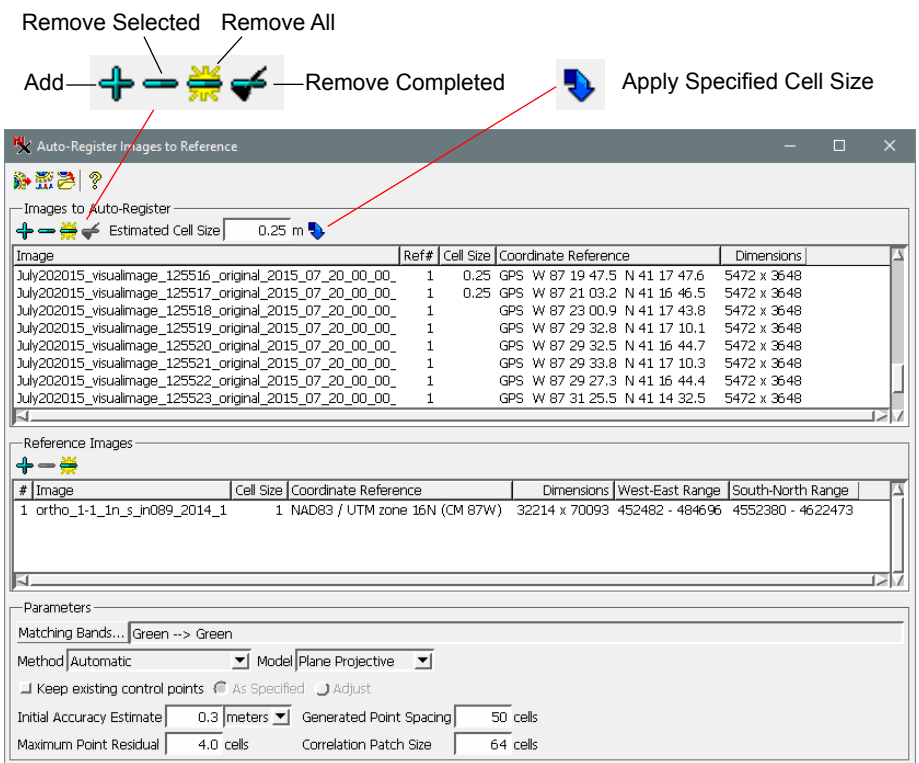
The auto-registration procedure uses keypoint matching and/or image cross-correlation techniques to register each input image to a reference image. See the Technical Guides entitled *Keypoint Matching for Image Registration* and *Auto-Register to Reference* for explanations of these image matching techniques.

Images to Auto-Register

To choose input images, press the *Add* icon button on the toolbar in the Images to Auto-Register box on the Auto-Register Images to Reference window (see illustration above). You can choose any number of grayscale or color-composite images residing in TNTgis Project Files or in any image format supported for direct use (JPEG, GeoTIFF, GeoJP2, MrSID, ECW, and others).

The selected input images are listed in the Image list, which automatically shows the coordinate reference system for each image's starting georeference and the dimensions of the image. After reference image(s) have been selected, the Ref# column in the input image list shows the number of the reference image that has been assigned automatically to each input image.

For input images with multiple starting georeference control points that establish the image scale and orientation, the computed image cell size is shown in the Cell Size column. If an input aerial camera image is only geolocated with coordinates for the camera position, the image scale and orientation are unknown and the Cell Size field is initially blank. You must enter an estimate of the image cell size in the *Estimated Cell Size* field above the list and press the *Apply Selected Cell Size* icon button to assign the value to any entries that you have currently highlighted in the list, or to all entries without a starting cell size if no entries are highlighted.

You can left-click on a list entry to highlight it, shift-click to highlight a range of entries, or control-click to toggle highlighting off or on for an entry. Pressing the *Remove* pushbutton removes highlighted entries from the list; pressing *Remove All* removes all entries. After processing is complete for all images, you can press the *Remove Completed* icon button to remove all images that were successfully registered, keeping in the list any images for which registration failed. You can then rerun these images using different matching parameters.

Reference Images

In the Reference Images box, press the *Add* icon button to select one or more grayscale or color-composite images to use as reference for auto-registration. For the most accurate results a reference image should have spatial resolution equal to or better than the input image.

The selected reference images are listed with columns showing their Cell Size, Coordinate Reference, Dimensions, and West-East and South-North Ranges. Each selected reference is assigned a number shown in the "#" column; this reference number is shown in the Ref# column in the input image list for the corresponding input images. The coordinate reference system for the computed georeference control points for each input image is automatically set to that of the matching reference image.
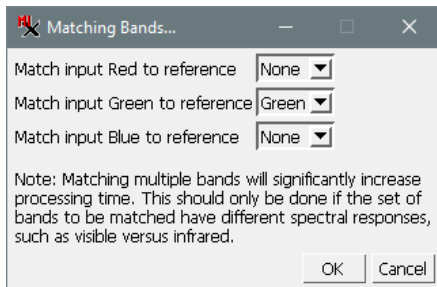
Reference image entries can be highlighted as for the input images and removed from the list if necessary using the *Remove Selected* and *Remove All* icon buttons.

Parameters

Matching Bands: If any of the input or reference images are color-composites, the image cross-correlation portion of the auto-registration procedure operates on particular image color components, and so you must designate for the input and reference image which color compent(s) to use for matching (or which component to match to a grayscale image). The first time you match color to color (or color to grayscale), the Matching Bands window (illustrated below for a color-color match) opens automatically so you can make these selections. Color assignments are saved as defaults for subsequent sessions and shown in the text field at the top of the Parameters box. You can press the *Matching Bands* pushbutton to open the Matching Bands window and change the color assignments.

The matching components you designate should have similar spectral properties, which may not be the same as their color assignments in a composite. For example, a color-infrared composite would have the near-infrared spectral band assigned to the red color component, the red spectral band assigned to the green color component, and the green spectral band assigned to the blue color component.

The Matching Bands window lets you designate one or more pairs of input and reference bands that have similar spectral properties.

A single matching pair of bands is usually sufficient to provide accurate control points. Using multiple pairs increases processing time and would only provide a benefit if the two matching pairs have significantly different spectral properties, such as a pair of green bands and a pair of infrared bands.

When keypoint matching is used in the auto-registration procedure, keypoints are determined for input and/or reference color images using a grayscale average of the color component cell values. If no keypoints are found in this stage, the designated matching components are used to find keypoints.

Method: Use the *Method* menu to choose the auto-registration method. The choices are Automatic, Cross-Correlation, Key Point Matching, and Estimate from Single Point. These methods are described in the TechGuide entitled *Auto-Register to Reference Image*.

Model: Use the *Model* menu to choose the mathematical model for the coordinate transformation from image to map coordinates that will be used to judge the fit of candidate control points. The options are Conformal, Affine, Plane Projective, and Polynomial models of Order 2 through Order 6. For a description of these models see the TechGuide entitled *Georeference: Choosing a Model*.

Keep Existing Control Points: this toggle button sets whether to keep pre-existing control points enabled in the final set or to automatically disable them, so that the final residual model and statistics are computed only from the auto-generated control points. Initial control points derived from nominal georeference provided with an image are likely to be much less accurate than the points found by auto-register, so it is advisable not to turn on the *Keep existing control points* option in this case. However, if you have manually placed accurate initial points from the reference or from GPS waypoints, you may want to keep them enabled after the auto-register operation is complete. If you choose that option, the radio buttons to the right of the toggle set whether to keep the specified image coordinates for the existing points or to adjust the image coordinates in accordance with the new residual model.

Cross-Correlation Parameters: The following settings in the Parameters box apply to the cross-correlation matching technique used in the Automatic and Cross-Correlation matching methods.

Initial Accuracy Estimate: this is an estimate of the typical spatial offset between input image features and their positions in the reference image. You can determine this manually by overlaying the input and reference image and measuring it, or use the nominal accuracy values for the image sensor type determined by the imagery provider. Setting a value much in excess of the actual accuracy can prevent auto-register from finding corresponding points.

Generated Point Spacing: the minimum spacing you would like between the generated control points. Smaller values will typically result in more control points being generated. Generating a large number of points (1000 or more) for medium and large satellite sensor images is beneficial in that a large number of accurate points in the residual model can dilute the effect of potentially less accurate points.

Maximum Point Residual: the maximum RMS residual value for accepting an auto-register control point. Candidate points with higher residual values are rejected. This parameter thus is a major control on the number of control points that are generated and their locations. Areas of an image with significant geometric distortion due to relief displacement will generate control points with higher residuals. A low maximum residual setting may result in rejection of all candidate points in these problem areas.

Correlation Patch Size: the size in cells of the square image neighborhoods used in each image to search for control points. The default setting (64 cells wide) is appropriate for medium to large images; a larger patch size significantly increases processing time.

Running the Process

When you have set the processing parameters, press the *Run* icon button to run the process immediately. Standard *Queue Job* and *Save Job* icon buttons are also provided to allow you to execute the process using the TNTmips Job Process system (see the Technical Guide entitled *System: TNTmips Job Processing System*).