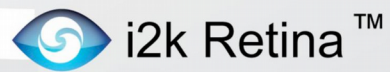


User Guide



Welcome to the i2k Retina™ image alignment and montaging software tool, the most sophisticated tool of its kind to be found anywhere. This page provides an overview of the user interface, one of three ways to interact with i2k Retina™. The second and third methods are a command-line executable and a C-level programming interface.

Summary Of Contents

- Trial Mode
- Purchase and Activation
- The Two Tools of i2k Retina™
- Image Modalities
- The i2k Retina™ User Interface
- Options and Preferences
 - Retinal image montage options
 - Retinal image align options
 - Photographic montage options
 - Photographic align options
 - Other modality montage options
 - Other modality align options
 - Overall preferences
- After Generate Montage or Align Image Begins
- Previewing Montages
- Previewing Aligned Images

Trial Mode

After installation, the software starts in trial mode, which allows users to test all of the i2k Retina™ functions, but the images it produces have subtle watermarks. Trial mode lasts for up to 14 days and 75 runs of the core align/montage functionality. At any time, the user can purchase an activation code and use it to activate the full functionality of the software, eliminating the watermarks.

Purchase and Activation

In order to purchase i2k Retina™ users must purchase a 16-bit activation code from the DualAlign website – <http://www.dualalign.com>. Here are the steps you need to take:

1. Click on Order Now from the i2k Retina™ dialog or go directly to the DualAlign website.
2. Place an Order.
3. You will receive the 16-bit code via email. The email containing the code may take up to several minutes (after your order) to arrive in your Inbox.
4. You may activate **i2k Retina™** by typing in the 16-digit activation code you received. You can do this when you start or restart the software from the i2k Retina™ Trial dialog, or by clicking Trial -> Standard Activation from the main menu.

If have trouble activating, and make several unsuccessful attempts, you may run our manual activation process instead by clicking Trial -> Manual Activation or by switching to manual activation from the Activation dialog. This process should only be required for customers with atypical internet connections.

The Two Tools of i2k Retina™

Fundamentally, i2k Retina™ has two tools, each taking N images as input and producing one or more image files as output. These output images are shown to the user in a preview window. Here are the two tools:

1. The montage tool builds a montage of the input images, blending them to create a single, composite image, with motion artifacts removed, seams eliminated, and illumination differences corrected.
2. The align tool registers the input images, mapping them into a common coordinate frame so that each pixel of each image correspondences to the same physical point. This allows users to combine images from different modalities, to visualize blood flow in angiograms, and to see how the same retina looks at different times on a pixel-by-pixel basis.

After the montage or the align tool completes, the resulting images are saved to output files, which then may be previewed in several ways. For montages, the preview window allows the user to zoom in and scroll around the montage. For aligned images, the preview plays the images in a sequence loop, with controls on the speed of playback, and controls providing the ability to pause and step forward and backward through the images.

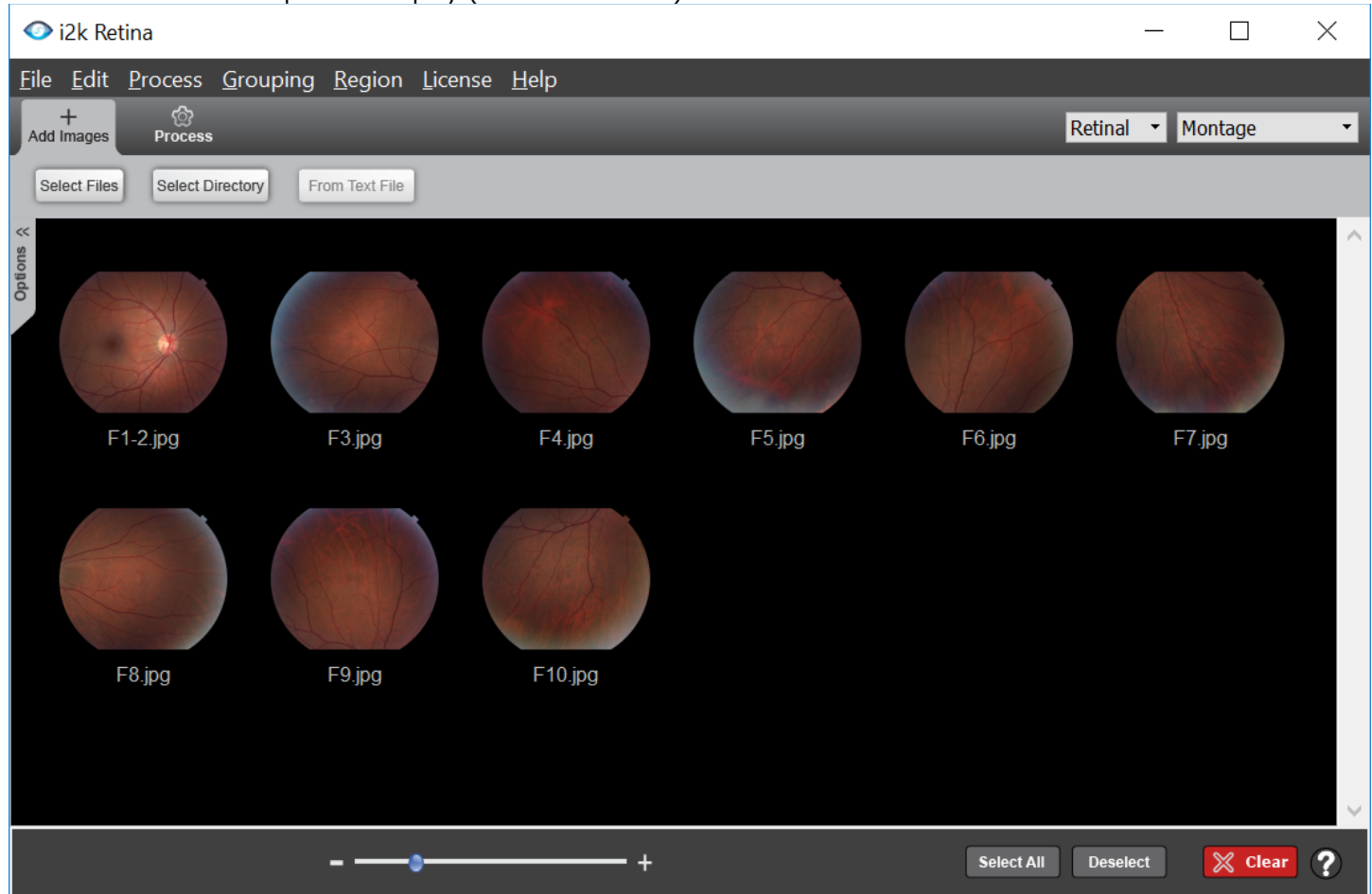
Image Modalities

While primarily a tool for retinal fundus images, i2k Retina™ works with a wide variety of image types. The software itself requires the user to choose between Retina, Photographic images and Other Modalities. The "Other Modalities" label is a catch-all, which means simply that the same processing is applied to each set of images that is labeled this way.

i2k Retina™ handles most common input image formats, including JPEG, PNG, PNM, BPM and TIF, handling 16-bit versions of PNG and TIF. This list will be extended in the future, in part based on customer demand.

The i2k Retina™ User Interface

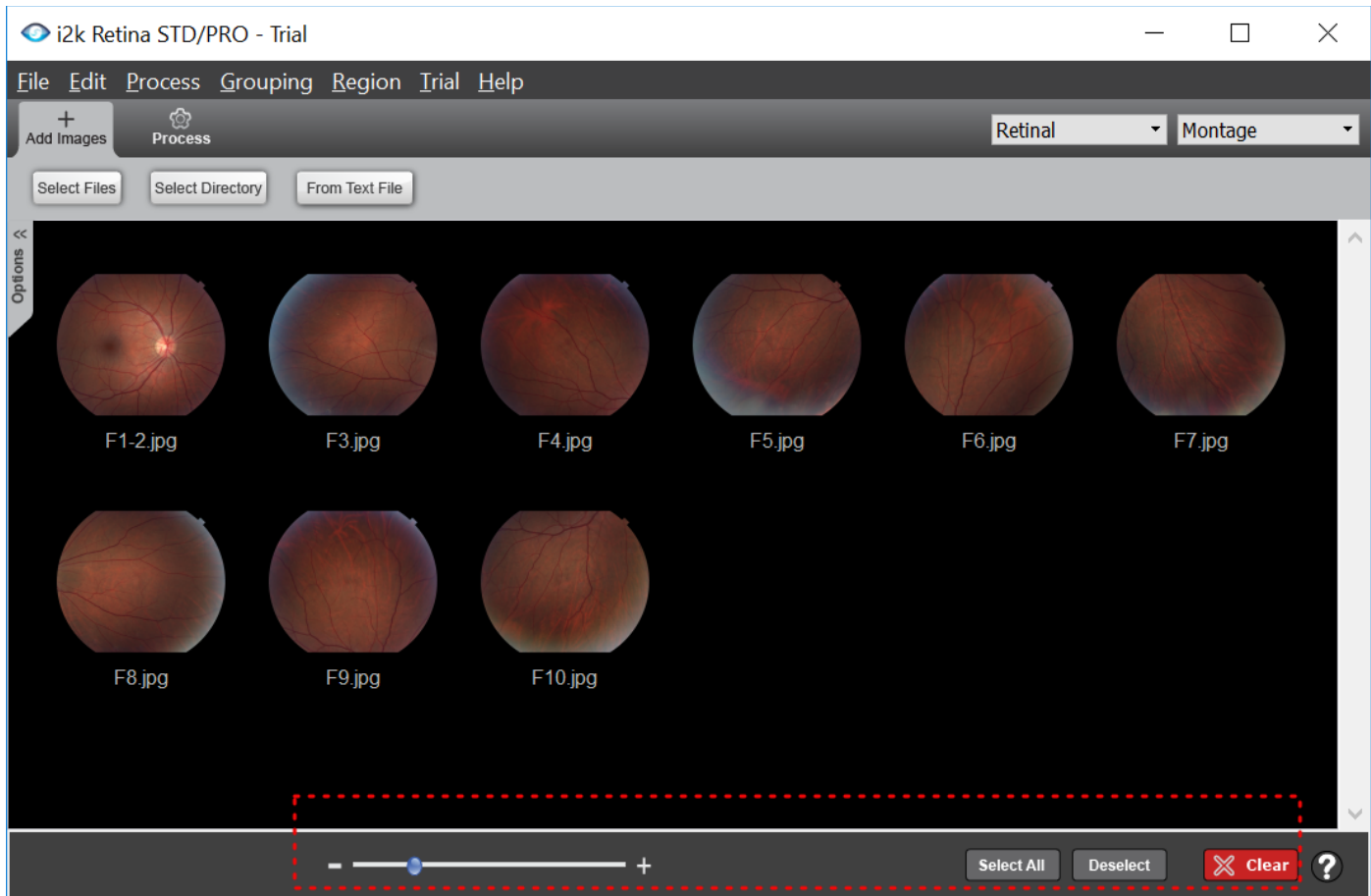
Everything about the user interface is built around input to, control of, and output from the Align and Montage tools. Across the top of the display (below the menus)



from this screen, the user may

1. Add Images to the thumbnail area. These are added to the images that have already been placed in the area, allowing images from different folders to be considered at the same time.
2. Select which added images to process.
3. Pick image type and functions to perform (far right drop-down controls)
4. Engage the processing mode and process (separate tab control below menus)
5. When processing is complete ... clear images (button) so that new images and process might be entertained.

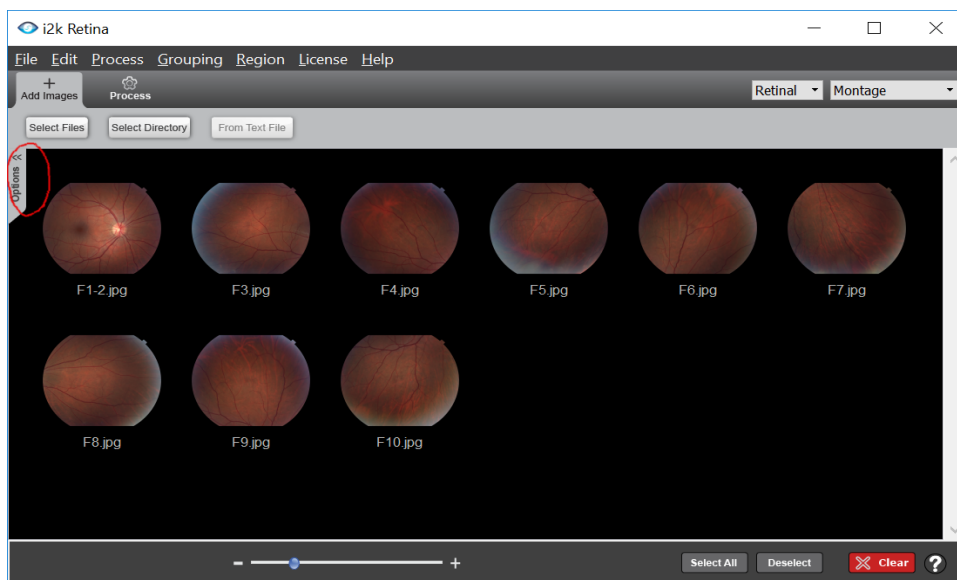
Turning next to the controls across the bottom of the i2k Retina™ display, there is a slider to control size of the thumbnails, and buttons to control the selection of images within the display (see red annotations).



Of course, clicking on the thumbnails themselves is the primary means of selecting a thumbnail. (Note that right-clicking on a thumbnail and then selecting property gives some details on the image.) Once two or more thumbnails are selected, the user can click the process button (on process tab) to launch the main montaging and alignment computations, which are applied to the selected thumbnails.

Options and Preferences

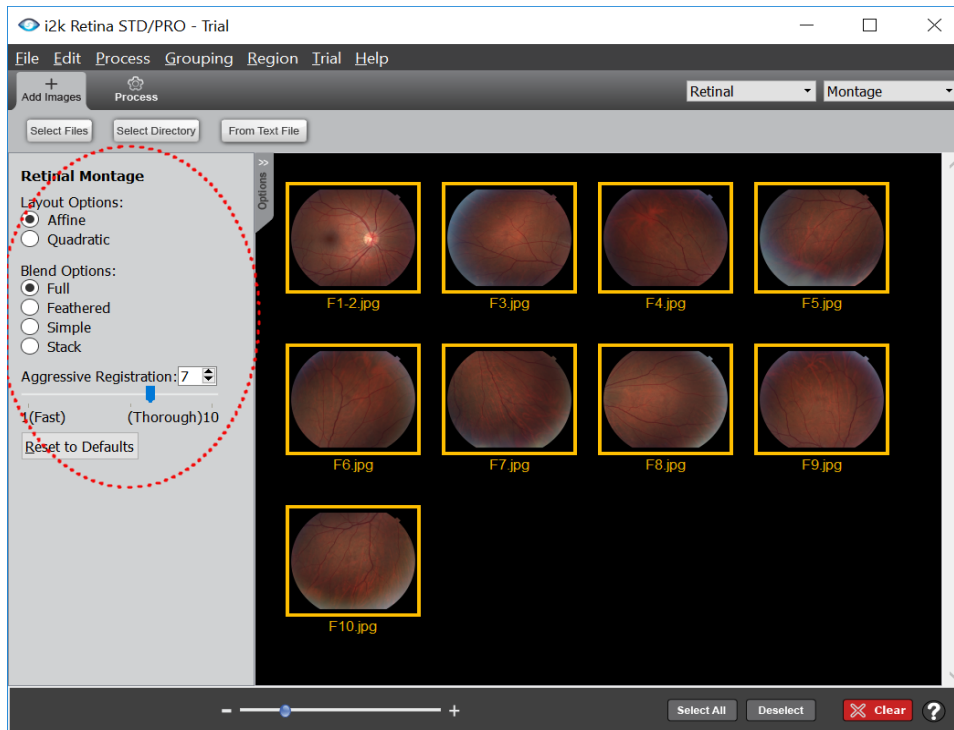
The left side of the central display shows an options tab for selecting a number of options for aligning and for montaging images.



The options on the tab change with the choice of image type (drop down upper right). Fortunately, the choices fall into just a few categories to document, with layout and crop being the primary categories: the layout options control the arrangement of the images relative to each other, while the crop options control the cropping of the final montage and the final aligned images. These combinations are explained in the following six subsections. A seventh subsection explains the overall system preferences, available under the File Menu on a Windows machine or the i2k Retina menu on the Mac.

1. Retinal / Montage Options

For retinal fundus images, the montaging options are quite simple. Unlike other modalities, there are no layout options because the layout is dictated by the geometry of the retinal surface and by the optics of fundus cameras. The masking process is applied automatically to retinal images. Users who are working with different types of retinal images other than color, red-free and fluoresceins are encouraged to try "Other Modalities".



Blend Options

Three options are offered for blending the intensities of retinal images in forming the montage:

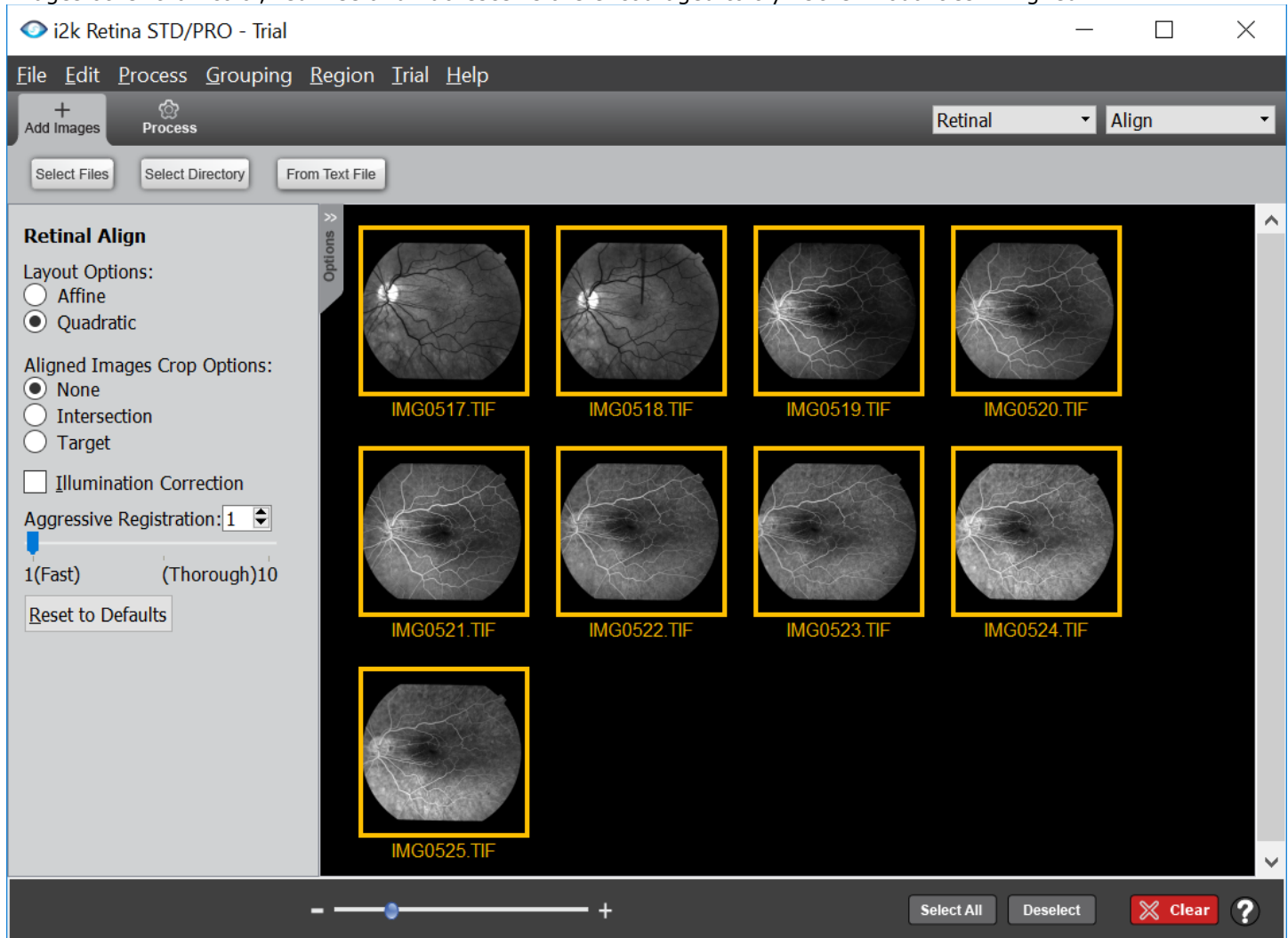
- Full blending implies that i2k Retina's illumination correction and seam selection algorithms, specialized to retinal images, will be applied to the aligned images prior to forming the montage. This gives the cleanest and most seamless result. It also takes the most time since the software prior to forming the final montage must carefully analyze the intensities.
- Feathered blending combines the intensities in a smoothly weighted averaging process, producing a gradual transition between images without correcting for illumination artifacts.
- DualAlign also provides lesser options for Blending of *Simple* and *Stack* ... if you chose to try them.

Aggressive Registration

Changing this setting to a higher value tells i2k Retina to be more aggressive than usual in trying to align each pair of images. This allows it to handle tougher cases while taking a bit more computation time. On rare occasions this leads i2k Retina to make mistakes, so this should be used only when ordinary registration fails and when the user is certain the images should be aligned.

2. Retinal image align options

For retinal fundus images, the align options are quite simple. Unlike other modalities, there are no layout options because the layout is dictated by the geometry of the retinal surface and by the optics of fundus cameras. The masking process is applied automatically to retinal images. Users who are working with different types of retinal images other than color, red-free and fluoresceins are encouraged to try "Other Modalities". Aligned



Aligned Images Crop Options

The Aligned Images Crop Options controls how the aligned retinal images are cropped individually before they are saved. There are three possibilities:

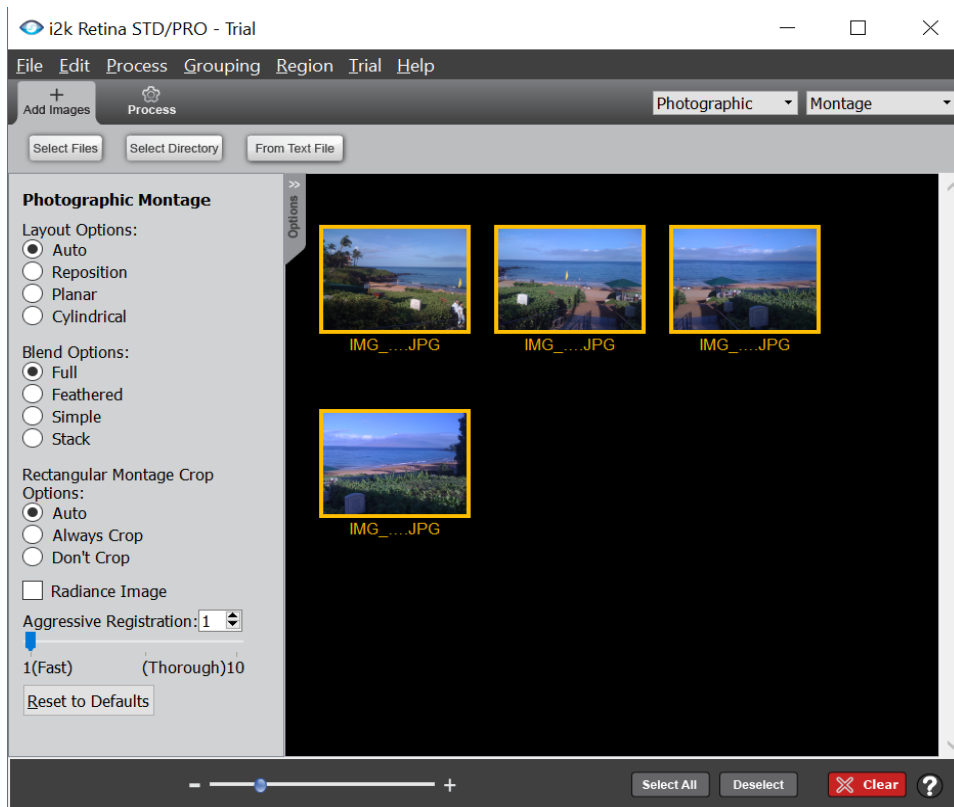
- If the user clicks None then no cropping is applied.
- If the user clicks Intersection then the images are cropped to their intersection. If the intersection is empty, then no cropping is applied.
- If the user clicks Target, then after the Align Images button is pressed to start the alignment process, a new window pops up for the user to choose one of the selected images as the "target". The alignment process then continues and after it is done, the aligned images are cropped, restricting them to the area of the (aligned) target image. Of course, the target image itself will not be cropped.

Aggressive Registration

Changing this setting tells i2k Retina to be more aggressive than usual in trying to align each pair of images. This allows it to handle tougher cases while taking a bit more computation time. On rare occasions this leads i2k Retina to make mistakes, so this should be used only when ordinary registration fails and when the user is certain the images should be aligned.

3. Photographic / Montage options

The options for Photographic Montages are the most extensive in i2k Retina:



Layout Options

Experimenting with these and understanding their behavior can improve your montages. i2k Retina offers four layout modes for photographic montages:

Auto

When Auto is selected, which is the default, i2k Retina automatically chooses between the three options, Cylindrical, Planar and Reposition. The automatic selection between these is based on evaluating what each does to the photos in a particular montage and choosing the one that appears to be the best. Instead of letting i2k Retina choose the layout automatically, you may choose one of the three options yourself.

Cylindrical

This is most appropriate when the images are taken by sweeping the camera left-to-right or right-to-left, perhaps using multiple levels of sweeps. Cylindrical maps the photos onto a virtual cylinder and then unwraps the cylinder to create the flat montage. In doing so, some curving can be introduced near the top and bottom of the montage.

Planar

This is most appropriate when taking pictures of something flat, such as the facade of a building or a painting. Planar maps all the photos onto a single flat surface. Photos well-away from the center of the montage may become somewhat stretched during this process.

Reposition

This is a simplified version of both cylindrical and planar and may be used when the main subject is far from the photographer and there is little of specific interest near the top or bottom of the photos (e.g. sky in the top third and water in the bottom third). Reposition also places the photos on a flat surface, but only does so by moving the individuals photos up, down, left and right. This does not allow enough flexibility to create seamless montages, especially on the top and the bottom, but sometimes the magic of seam selection can hide the visual differences, for example in the clouds of the sky and the ripples of the water. When Reposition creates a seamless montage, it is the best choice of all, but look at your results carefully. Also, on rare occasions, Reposition may be the ONLY layout option that works.

Montage Crop Option

When i2k Retina forms the montage, the outlines of the photos will form an irregular shape, especially when many photos are being combined. Most users will want this montage cropped to a rectangular final image. i2k Retina finds the largest possible rectangle that fits inside the montage, and then decides whether or not to crop. This decision is controlled by the prior selection of buttons:

- The Auto button indicates that i2k Retina should crop the montage as long as enough of the image area is preserved within the rectangle. The percentage of area that must be preserved in order for cropping is controlled as a user preference.
- The Always Crop button tells i2k Retina to crop the montage no matter how much montage area is outside the largest possible rectangle.
- The Never Crop button tells i2k Retina to leave the montage uncropped.

Radiance Image

During montage generation, i2k Retina estimates properties of the camera and the lens as the basis for combining the photos. In doing so, it also estimates the amount of light - the "radiance" that formed each pixel. When generating the final montage, the radiance values are converted back to colors. This conversion balances the twin goals of preserving the original colors taken by the camera and combining the photos into a pleasing, seamless whole.

In most cases, this works just fine. Advanced users wanting more control over the final pixel colors and brightness values, may want i2k Retina to stop with the radiance values, saving them as a "Radiance Image". This option is most useful when scene has significant brightness variation, with photos being taken in and out of shadows.

The Radiance Image is akin to a High-Dynamic Range image, although it is acquired by moving the field of view of the camera rather than by fixing the field of view and taking multiple exposures. The result is stored in a 16-bit-per-color TIFF image (ordinary TIFF images have 8-bits per color). Users not familiar with the properties of image radiance will notice that the resulting montage has a dark appearance, almost like the shadows and darkening of the sky at dusk.

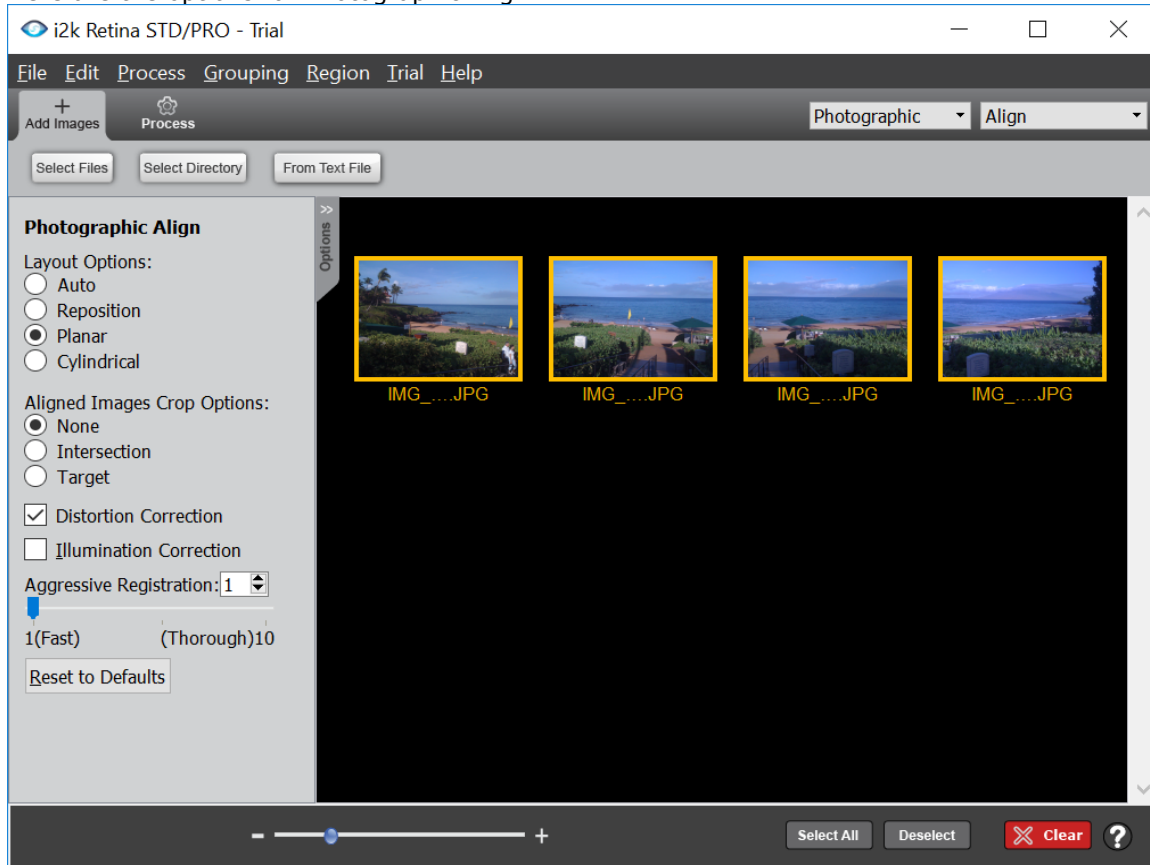
In short, i2k Retina effectively offers two options in handling the colors and brightness values. The default option generates as faithful a combination of the original photo values as possible. The Radiance Image option generates values roughly proportional to the original radiance values, allowing the user to create the final colors from these using a different tool.

Aggressive Registration

Clicking this button tells i2k Retina to be more aggressive than usual in trying to align each pair of images. This allows it to handle tougher cases while taking a bit more computation time, but also, on rare occasions, causes it to make some mistakes. On rare occasions this leads i2k Retina to make mistakes. Aggressive registration is not recommended for photographic image montage, except in very rare circumstances.

4. Photographic / Align options

Here are the options for Photographic Align:



Layout Options

For photographic images, there are four choices of layouts: Auto, Reposition, Planar, and Cylindrical. These are explained in detail in our [xforms-and-matches.pdf](#) document (please contact support to receive this document.)

Aligned Images Crop Options

The Aligned Images Crop Options controls how the aligned images are cropped individually before they are saved. (This differs from the Final Montage Crop Option, which crops the composite image.) There are three possibilities here:

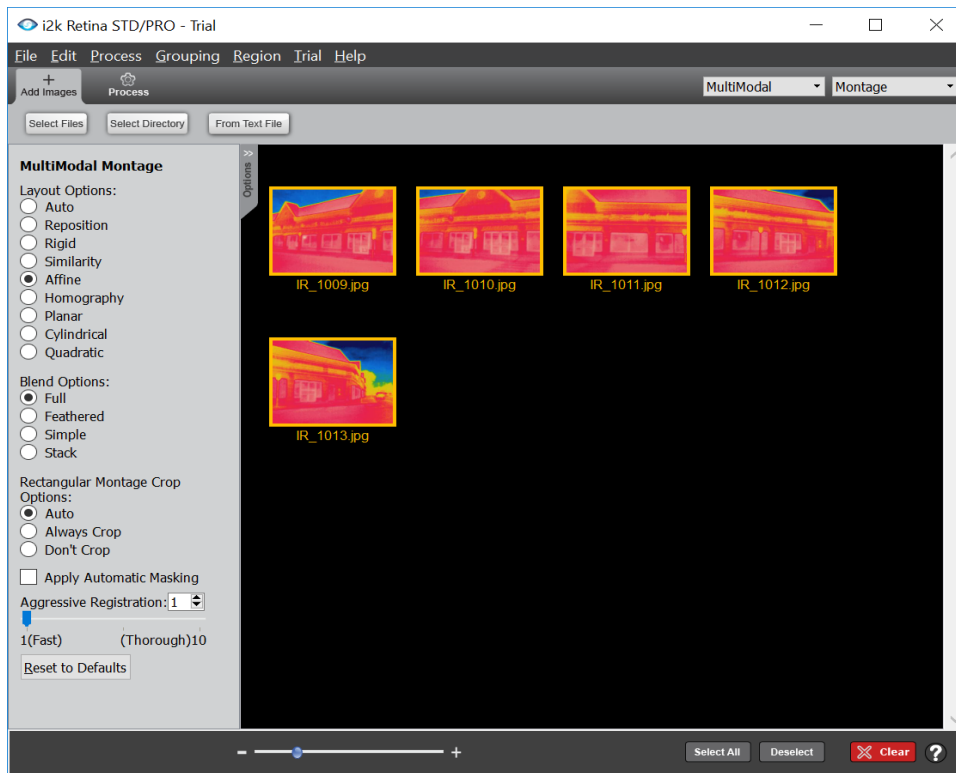
- If the user clicks None then no cropping is applied.
- If the user clicks Intersection then the images are cropped to their intersection. If the intersection is empty, then no cropping is applied.
- If the user clicks Target, then after the Align Images button is pressed to start the alignment process, a new window pops up for the user to choose one of the selected images as the "target". The alignment process then continues and after it is done, the aligned images are cropped, restricting them to the area of the target image. Of course, the target image itself will not be cropped.

Aggressive Registration

Clicking this button tells **i2k Retina** to be more aggressive than usual in trying to align each pair of images. This allows it to handle tougher cases while taking a bit more computation time. On rare occasions this leads **i2k Retina** to make mistakes, so this should be used only when ordinary registration fails and when the user is certain the images should be aligned.

5. Multi-Modal / Montage options

Here are the options for Other Modalities Montage:



Layout Options

There are nine choices of layouts: Many are explained in detail in xforms-and-matches.pdf document. For all others ... hover over the item to get tool-tip description.

Montage Crop Option

When **i2k Retina** forms the montage, the outlines of the images will form an irregular shape, especially when many images are being combined. Most users will want this montage cropped to a rectangular final image. i2k Retina will find the largest possible rectangle that fits inside the montage, and then decide whether or not to crop. This decision is controlled by the prior selection of buttons:

- The Auto button indicates that i2k Retina should crop the montage as long as enough of the image area is preserved within the rectangle. The percentage of area that must be preserved in order for cropping is controlled as a user preference.
- The Always Crop button tells i2k Retina to crop the montage no matter how much montage area is outside the largest possible rectangle.
- The Never Crop button tells i2k Retina to leave the montage uncropped.

Apply Masking

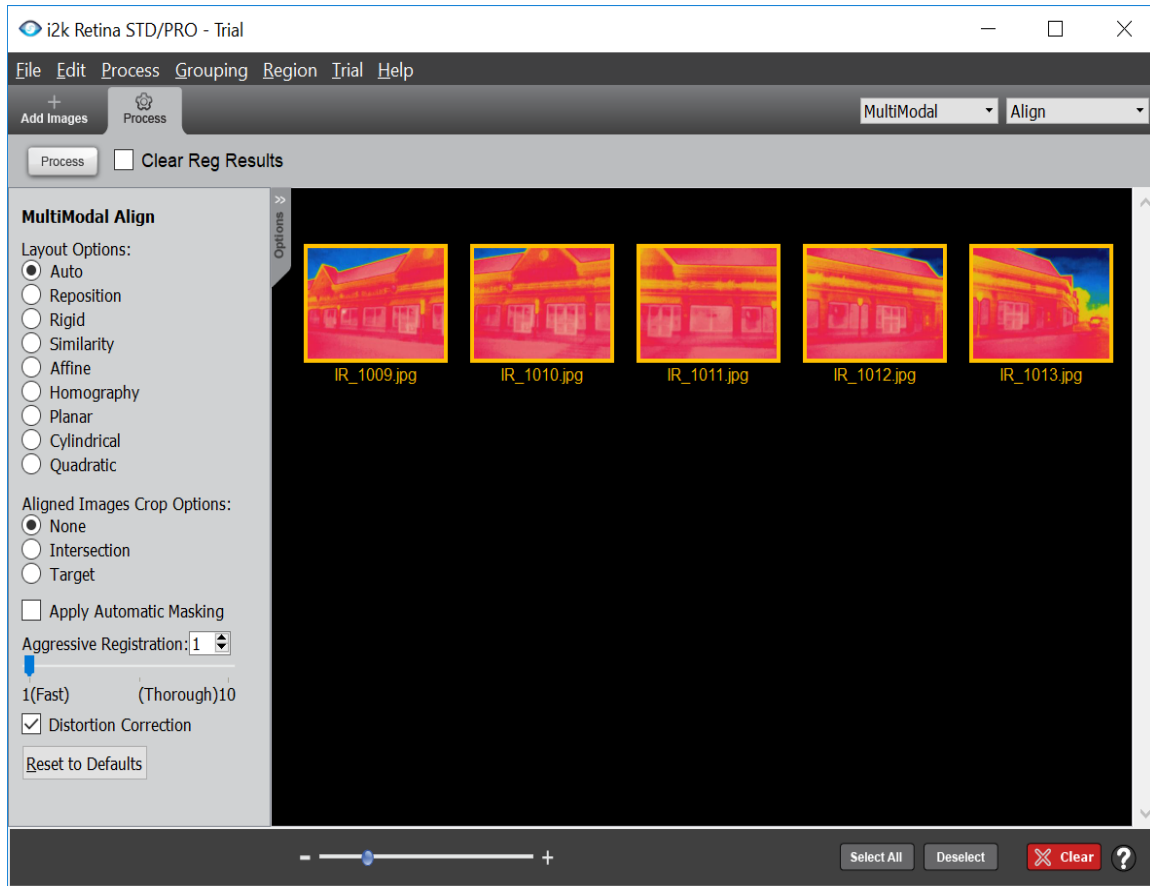
When this is selected, i2k Retina tries to find a convex border of pixels around the true image contents. This border region can be either bright or dark. The region is eliminated from consideration during the registration process.

Aggressive Registration

Changing this setting to higher value tells **i2k Retina** to be more aggressive than usual in trying to align each pair of images. This allows it to handle tougher cases while taking a bit more computation time. On rare occasions this leads **i2k Retina** to make mistakes, so this should be used only when ordinary registration fails and when the user is certain the images should be aligned.

6. Multimodal / Align options

Here are the options for Other Modalities Align:



Layout Options

There are nine choices of layouts: Many are explained in detail in xforms-and-matches.pdf document. For all others ... hover over the item to get tool-tip description.

Aligned Images Crop Options

The Aligned Images Crop Options controls how the aligned images are cropped individually before they are saved. There are three possibilities:

- If the user clicks None then no cropping is applied.
- If the user clicks Intersection then the images are cropped to their intersection. If the intersection is empty, then no cropping is applied.
- If the user clicks Target, then after the Align Images button is pressed to start the alignment process, a new window pops up for the user to choose one of the selected images as the "target". The alignment process then continues and after it is done, the aligned images are cropped, restricting them to the area of the (aligned) target image. Of course, the target image itself will not be cropped.

Apply Masking

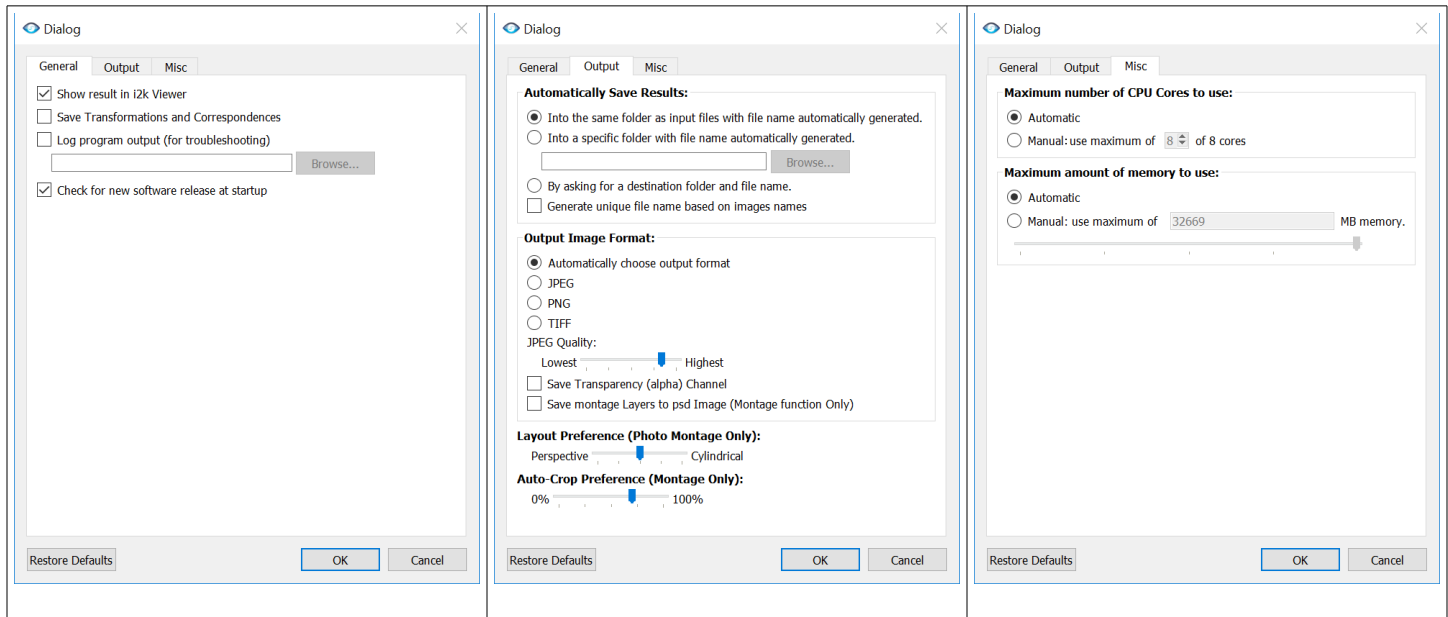
When this is selected, **i2k Retina** tries to find a convex border of pixels around the true image contents. This border region can be either bright or dark. The region is eliminated from consideration during the registration process.

Aggressive Registration

Clicking this button tells **i2k Retina** to be more aggressive than usual in trying to align each pair of images. This allows it to handle tougher cases while taking a bit more computation time. On rare occasions this leads **i2k Retina** to make mistakes, so this should be used only when ordinary registration fails and when the user is certain the images should be aligned.

Overall preferences

i2k Retina presents the user with a number of preferences to control its output and its overall behavior.



Output Tab / Save Results

i2k Retina has 3 options for saving results. The first, is to save each image to the same folder where the original images reside. If the images came from multiple folders, then the chosen folder is the most recent one. The names of the output images are automatically generated. When the Align tool is used the aligned images are saved into a newly created sub-folder.

The second option is to specify the output folder only, with the actual names of the images generated automatically, just like the first preference. This preference is useful when users want to collect all results in one place. i2k Retina ensures that previous results are not overwritten.

The third option is for manually specifying the folder and name of the output images. For each set of results generated, the user will be asked to specify these after clicking the Generate Montage button or the Align Images button. For Align, the name specified by the user will only be used to name the folder in which to store the aligned images.

Output tab / Image Format

i2k Retina, by default, attempts to match the output image file formats to those of the input images. It provides preferences to override this, forcing the output to be JPEG, PNG or TIFF. When the user chooses to output a Radiance Image under Photographic Montage, only PNG and TIFF are allowed.

Output tab / JPEG Quality

JPEG allows a trade-off between the size of the file and the appearance quality of the image when it is reloaded into a viewer. This trade-off may be controlled using the JPEG Quality bar under the Preferences.

- Sliding the bar to the left will result in smaller output files, but eventually the images will start to have a "blocky" appearance.
- Sliding the bar to the right will result in larger files, but higher quality images.

For most applications, the default setting is just fine. The main exception is users who want to examine or print the output at high resolution. In this case, PNG or TIFF output may be better anyway.

Output tab / Layout Preference

(Photo Montage Only) Users of the Photographic Montage tool who prefer layout choices different from those made automatically by i2k Retina can bias the Auto layout choice towards Perspective or Cylindrical.

Output tab / Auto-Crop Preference

(Photo and Other Modalities Montage Only) This slider controls the area that must be preserved in order to crop the montage to the chosen largest inscribed rectangle.

- Sliding the bar to the right, toward 100%, tells i2k Retina that a larger percentage of the montage area must be preserved in order for cropping to be applied. Making it 100% is equivalent to the "Don't Crop" option.
- Sliding the bar to the right tells i2k Retina to crop more and more irregularly shaped montages. Setting the bar all the way to the left, to 0, is equivalent to the "Always Crop" option.

General Tab / Show Results in i2kViewer

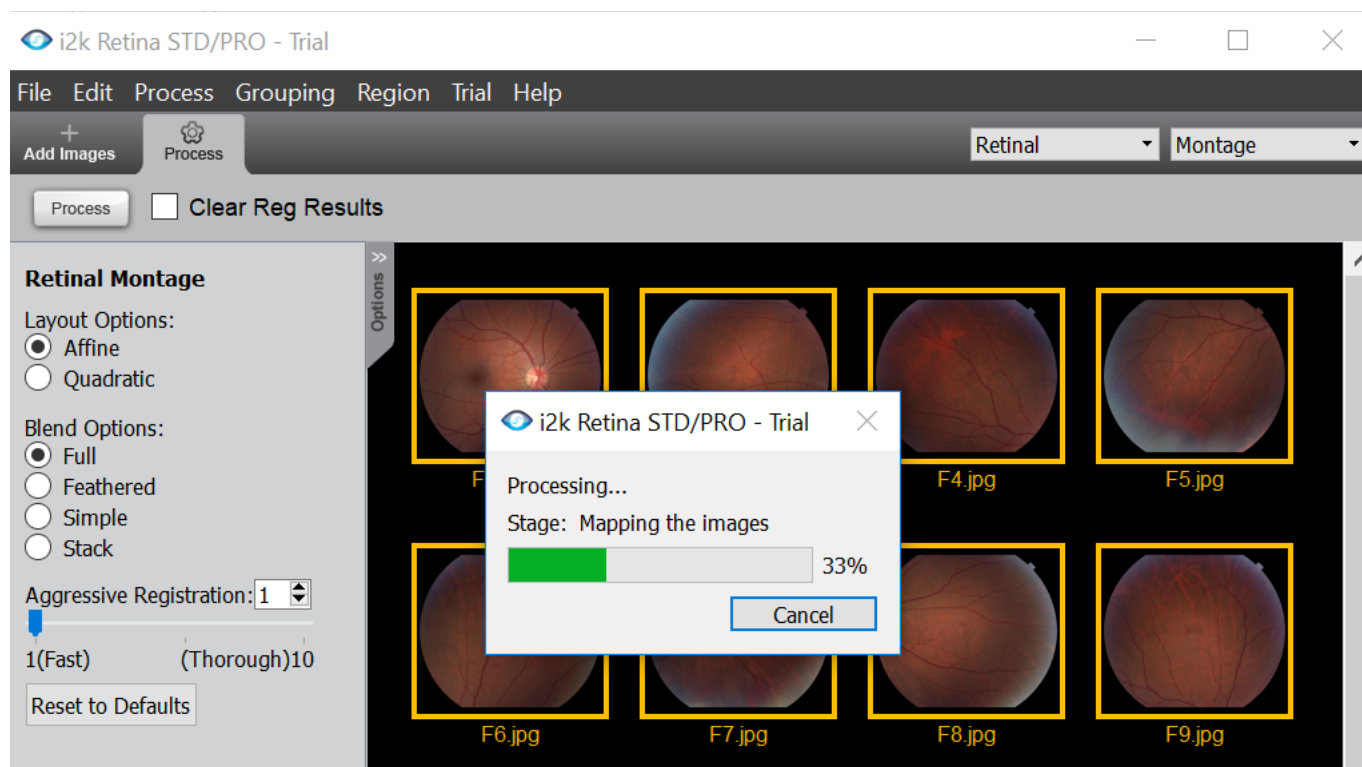
Users may choose whether to see a preview of the montage or the aligned images by clicking this preference. Results are always saved to an output file, regardless.

General tab / Save Transformations and Correspondences

Selecting these preferences tells i2k Retina to save the inter-image transformations and feature correspondences used to estimate these transformations. This is useful when the user wants to apply further processing to the results of i2k Retina. The form of the output is explained in xforms-and-matches (please contact support to receive this document.).

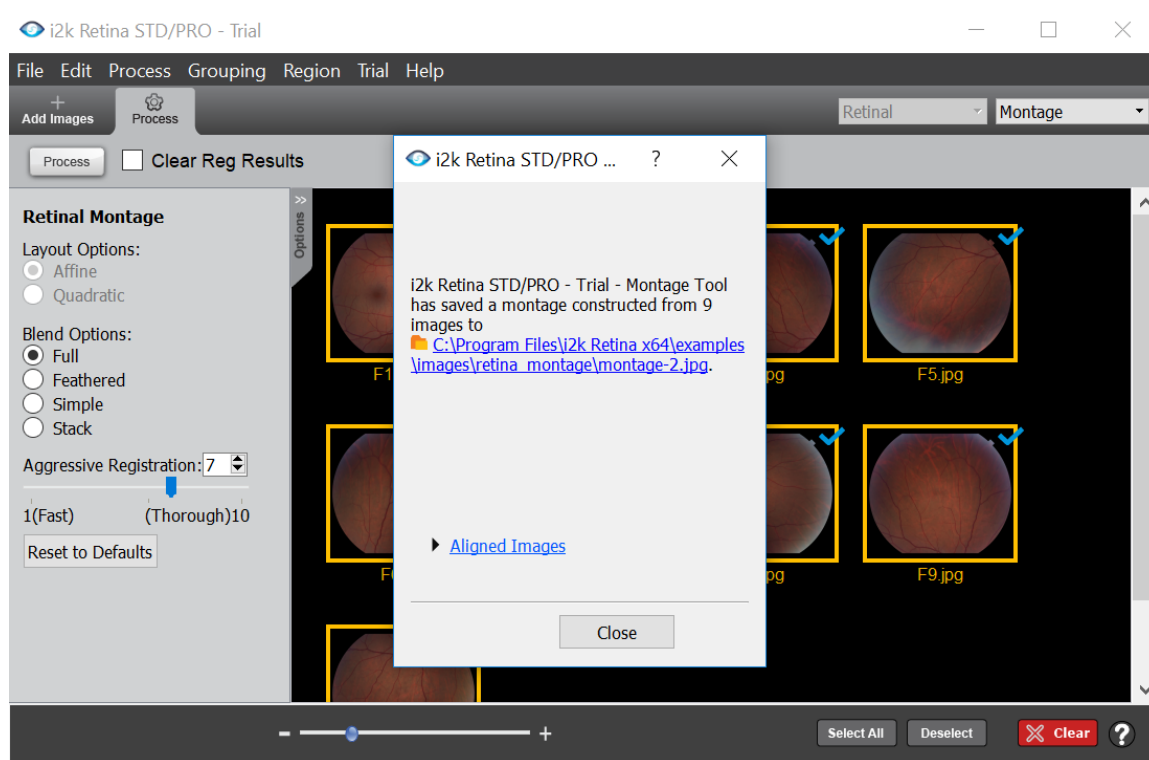
After Generate Montage or Align Image Begins

Once the thumbnails have been selected, the process tabs and its options decided on, and then the process button pressed, then the main processing of i2k Retina begins. At this point a modal dialog pops up to present the user with feedback regarding what phase of processing is running and also shows a progress bar. This bar shows the approximate percentage of work i2k Retina has completed and presents the user with the option to cancel the computation.

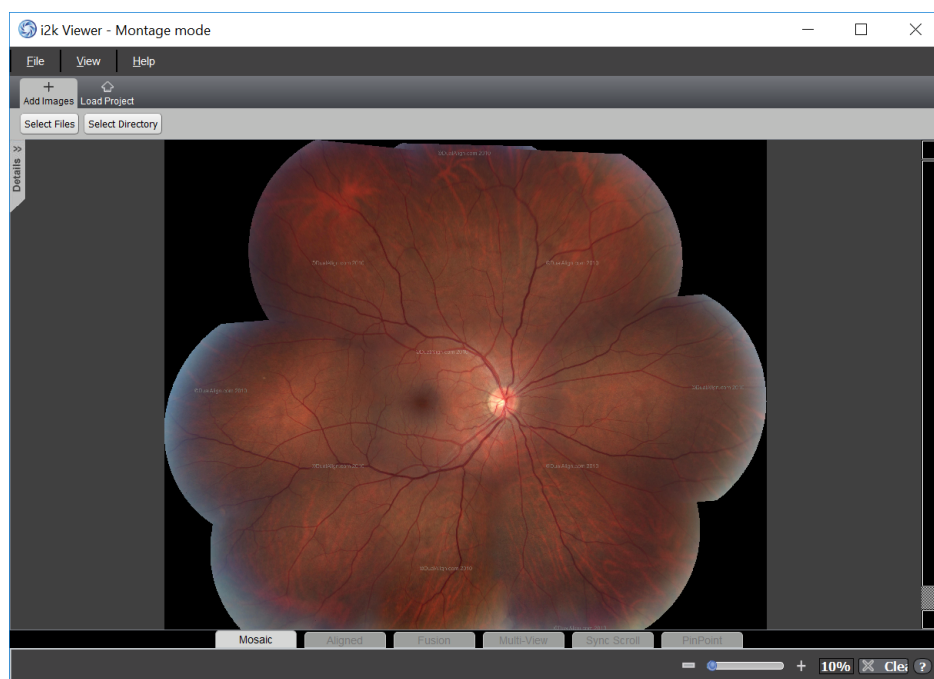


Previewing Montages

Once the computation finishes, a summary dialog will be presented to the user, given information on the montage file name and the option to launch i2k Viewer. If the user clicks Okay button, i2k Viewer will be launched with the montage.

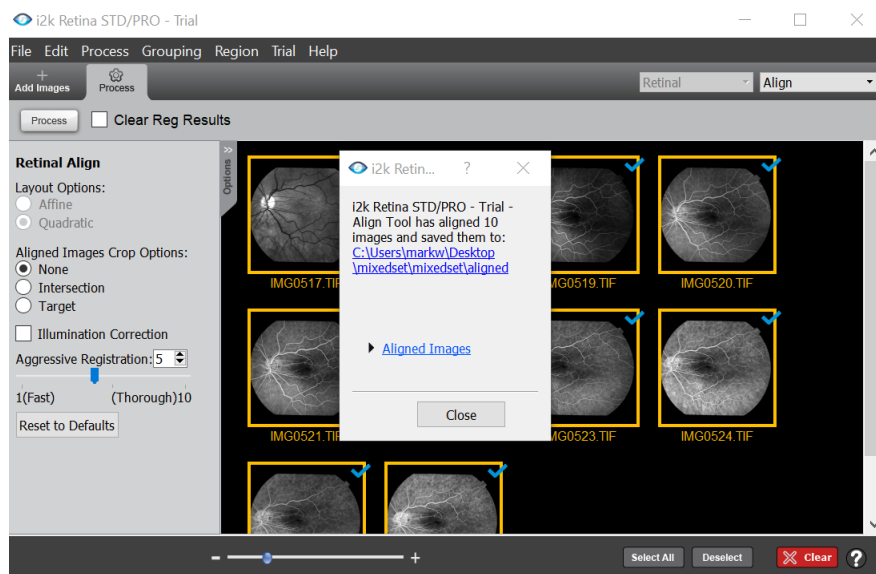


i2k Viewer shows the montage scaled to fit the screen. If the montage is larger than the screen, the user will be able to scale it up to see it at higher resolution. The user can also increase the size of the display. Eventually, scrollbars will appear to allow movement around the montage. Grabbing the montage with the mouse, also allows the user to move around the montage. The mouse track wheel gives the user additional control over zooming.



Previewing Aligned Images

Just as with the montage functionality, once the computation finishes a summary dialog will be presented to the user giving information on the number of images aligned, the folder where the aligned images are stored, and the option to launch i2k Viewer. If the user clicks Okay button, i2k Viewer will be launched with the aligned images.



i2k Viewer shows each aligned image, one at a time. (The folder where the aligned images are saved and links to the aligned images appear at the top of the display.) Controls on the lower left of the display allow the user to zoom in on the aligned images. The controls in the center allow the user to determine the time interval between the display of each successive image. Finally, the four buttons on the right allow the user to step forward and backward through the images, pause the animation, and restart it.

