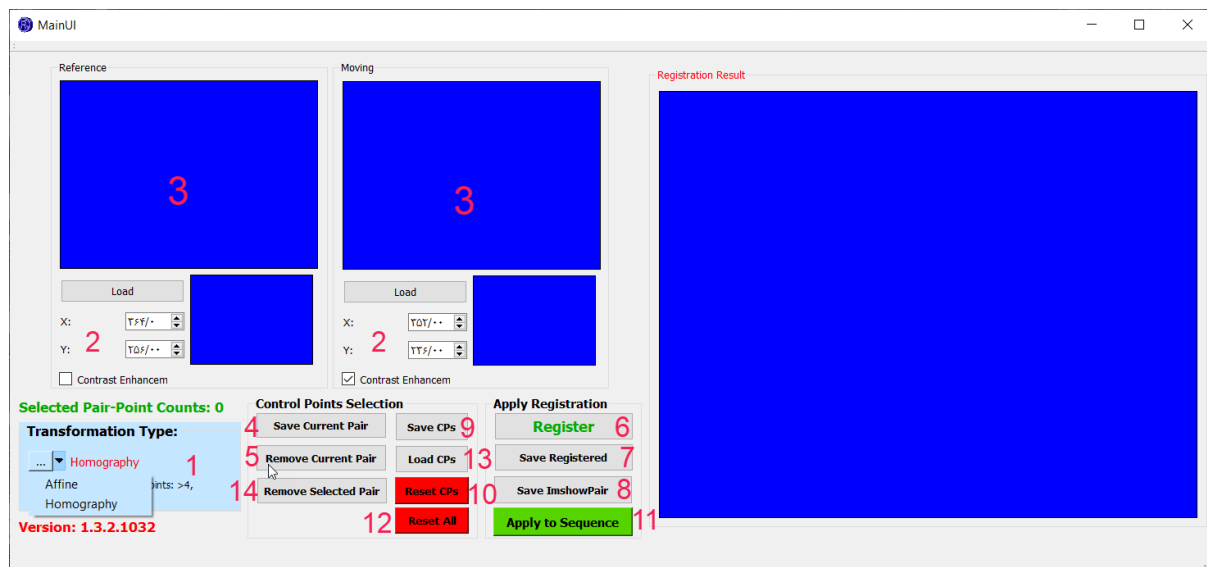


## Manual Image Registration User Guide

This software registers two images, named reference and moving, using control points selected manually by the user. After selecting point, this application employs one of two transformation techniques, which are selectable by the user, to register two images.

An interface in Qt IDE is designed to help the user register the reference and moving images with ease. The application provides two transformation type, namely affine and homography, which are optionally selectable on the UI.

An overview of the UI is provided in the following:



The following procedure should be followed in order to register two images with the help of control points. It should be noted that each stage in this procedure is shown in the picture above with a number from 1 to 14:

1. Choose one of the conversion methods. The affine method requires exactly 3 control points to register the images and the homography method requires at least 4 points to register (but it is recommended to select more points, 7 or 10 points or more, for good results).
2. From the load section, load the desired frames as the reference and moving images.
3. Manually select the corresponding control points on both the reference and moving images carefully. To get the best results, control points should be distributed across the image as far as possible and not concentrated in a particular area. By hovering over each image, the region under the current position of the mouse will be magnified to facilitate selecting control points and increase the accuracy of point selection process. After clicking on a position in either of the images, the mouse-current-position zooming is disabled. But you can still move the selected point location with the spinBox provided along the X and Y axes to achieve the most precise control point matching in reference and moving images. To simplify the task, an image enhancement capability, using CLAHE algorithm, can be activated using "Contrast Enhancement" checkbox for each of the reference and moving images separately. This

checkbox is placed under each image. The enhancement is automatically active for moving, but is not performed automatically for the reference image. In case it is needed, the user should check the checkbox provided under the reference image.

4- After selecting each pair of control points and making sure they are correctly matched, with this button save the desired pair of points and move on to the next pair of points. You need to select as many points as you require in your selected transformation type. (eg. Affine: 3, Homography: above 4). After each click on the "Save Current Pair", the value of the "Selected Pair-Point Counts" will increase by 1.

5. This option can be used if you want to delete the current point pair (or in case you have selected just one point on either of images).

6- After selecting the least required pairs of control points on both images, clicking on the button shown in the figure, the image registration operation will be done based on the selected control points and the result will be displayed in the "Registration Result window" with imShowPair technique (which is a method of displaying two images simultaneously in a window, in which each of input images appears in a specific channel of the resultant image).

7. This button stores the registered image of moving image, with the same format of the input moving image.

8. This button stores the image as imShowPair, with the same format of the input moving image.

9. This button stores the coordinates of the points (with sub-pixel accuracy of 0.2).

10- This button is used if you want to delete all control points you have selected so far. This enables you to start selecting control points from the beginning. Note that the selected control points will not be erased until this button is pressed. Otherwise, the selected control points will affect the registration process. The user can view and use the registration result to decide that each control point should be eliminated by right-clicking nearby the control point and pressing "Remove Selected Pair" button.

11- If you want to perform the registration for a sequences of frames of a specific scene, this button can be used to load the reference images from the directory of reference image address and the moving images from its respective directory. The software applies the selected control points and calculated transformation matrix to the all corresponding pair of frames (the sequence) and stores the results in two separate folders called "Imshowpair" and "Registered Moving Images" in a path set by the user. It should be noted that the format of these generated images depends on the format of the moving image loaded in the software initially.

12- When one scope of registration process is done, with this button you can reset all the current information and start the registration process on a new pair of reference and moving images.

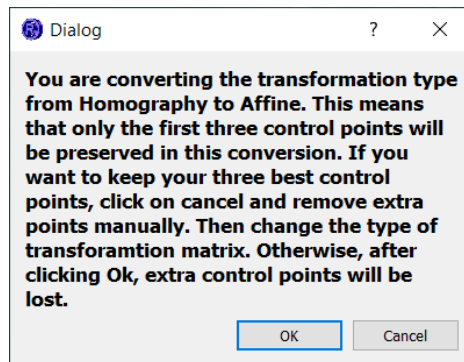
13. If you want to use the control points you have saved previously; you can load them using this button. It is worth mentioning that saving and loading control points happens using a .txt file.

14. This button can remove the previously selected control points separately so that if you right-click around the control points of the reference or moving images, the selected pair point will turn into blue, along with its pair in the other image. Then, by pressing the "Remove Selected Pair" button you can

remove the selected pair of control points. This will eliminate the effect of the removed points from registration process. If a pair is selected and the user wants to deselect these points, the middle click of the mouse will release the selected pair points.

### Caution:

Changing from affine to homography and vice versa after selecting the control points should be done delicately. This is because some points may be lost the method is switched. If you want to switch from affine to homography, the software automatically transfers the three pair points to the homography method. Then, at least one extra pair point is required for registering images. On the other hand, when you are switching from homography to affine, you will get the following message that by selecting ok only the first three pairs of control points from the homography point list will be transferred to the affine method and the rest of pair points will be discarded.



To get the idea how the result of the registration is shown, it is worth considering the following image. The output image, as shown below, sounds a natural gray-scale image (despite color inputs) when two images are registered perfectly. In other words, the output image shows that when two images are well-aligned, in the overlapping areas of the two images we witness a natural gray-scale rather than a two differently colored images that are misaligned. Areas marked in green or pink are areas in one image but not in the other.

