TimeLapseReg – an ImageJ plugin for drift correction of video sequence in time-lapse microscopy

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Introduction

- ***Goal***: drift correction of long sequence of time lapse microscopy images (small translations/rotations).
- ***User interface***: TimeLapseReg is is an ImageJ/Fiji plugin developed here to be used by biologists with a friendly user interface.
- ***TurboReg/StackReg***: TimeLapseReg uses the *de facto* standard "TurboReg" plugin for aligning and matching 2 images (source image and reference image).
- ***Validation***: Our plugin was practically tested on sequence of images.
- ***Application***: Calcium fluorescence imaging to reconstruct neuronal and glial cells populations activity.

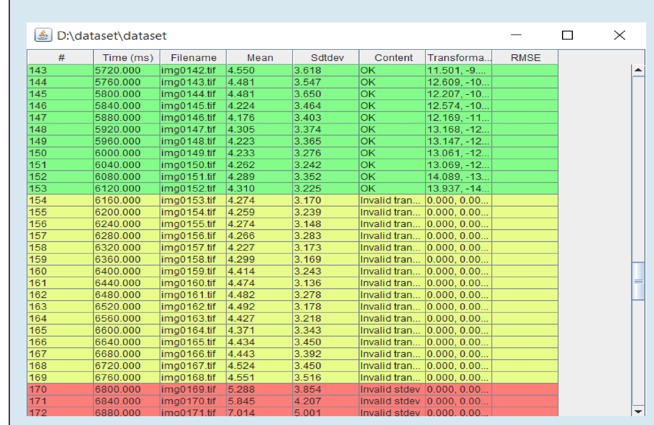
The TimeLapseReg plugin

- TimeLapseReg uses TurboReg which contains the engine for a high quality registration.
- TimeLapseReg plugin is a plugin for automatic alignment of frames of sequence using a user-defined reference image.
- User gets an option to choose the reference image by a number of metrics like average, maximum, browsing the image, etc.

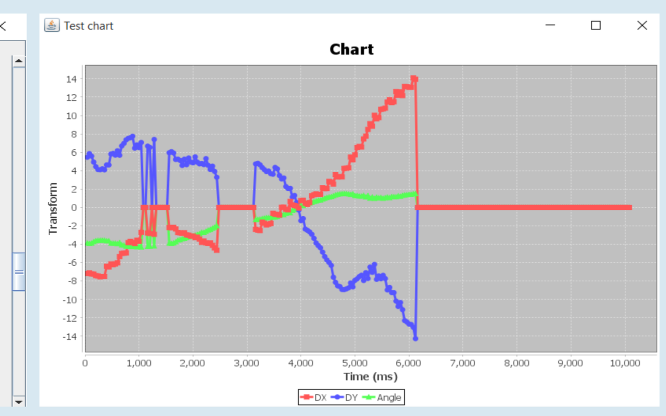
Features of TimeLapseReg

- User gets option to discard the specified frames in the pre-processing step.
- User gets the option to set the translation and rotation limits under which the transformation would be stable/valid.
- After computing the transformations the user can apply the transformation to any channel for aligning the images, example computing the transformation on the bright channel and applying them to the fluorescence channel.
- For long sequence of images, the processing could take tens of minutes, so it is important to provide real-time feedback-
  - ❑ By a table displaying the frames with information about each frame.
  - ❑ By a chart displaying the translation along x and y axis and the rotational transformation.
  - ❑ By drawing a trajectory on the reference image of the center point.

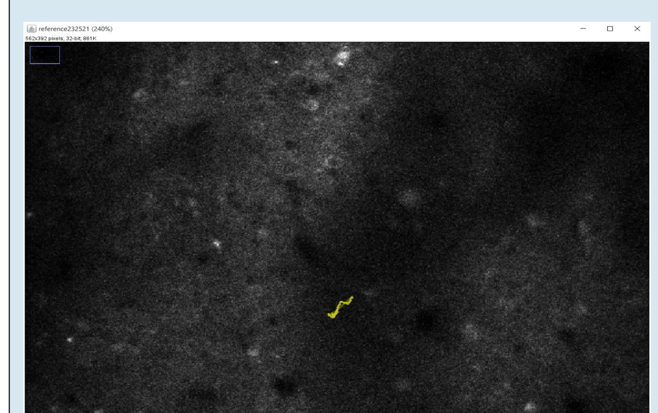
User FeedBack



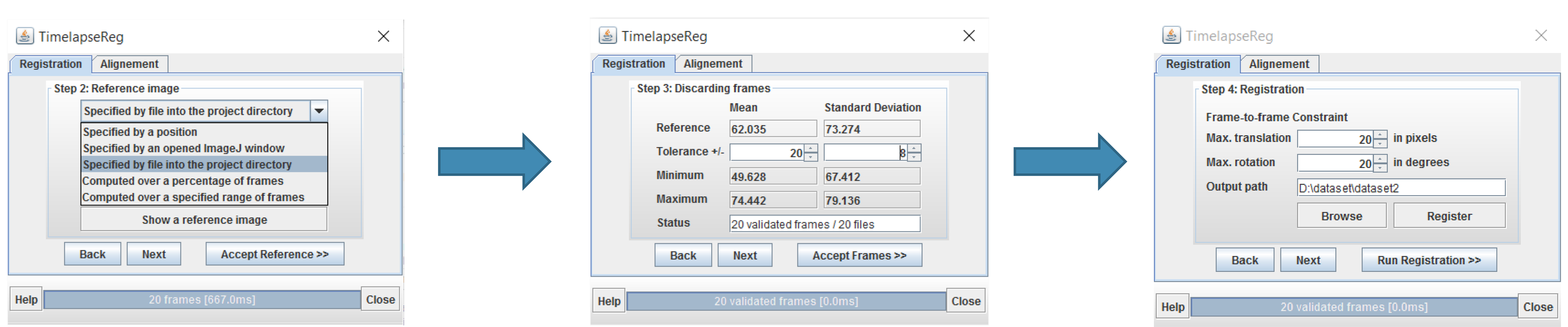
Feedback 1 Table showing the user the information of the frames

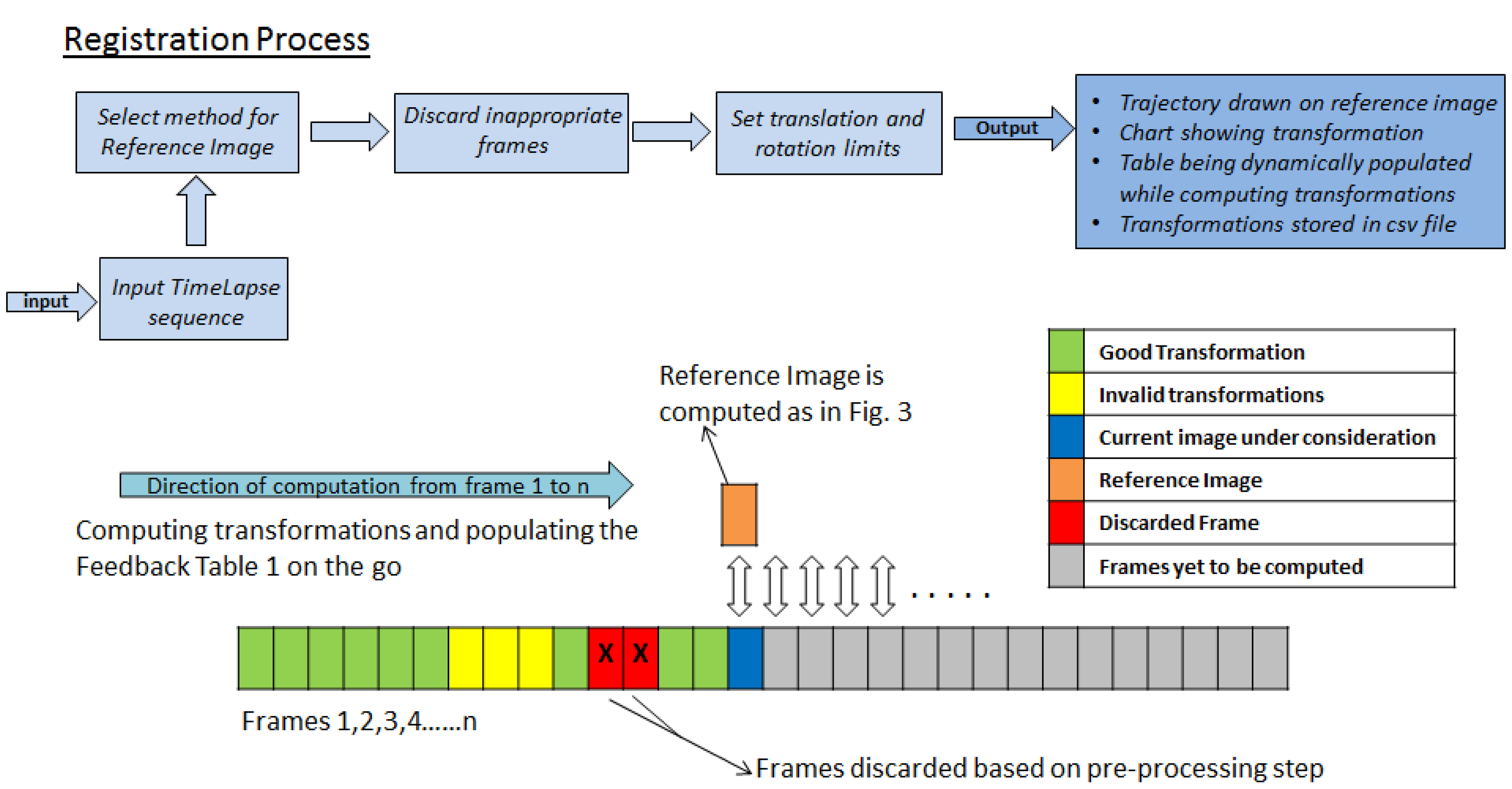


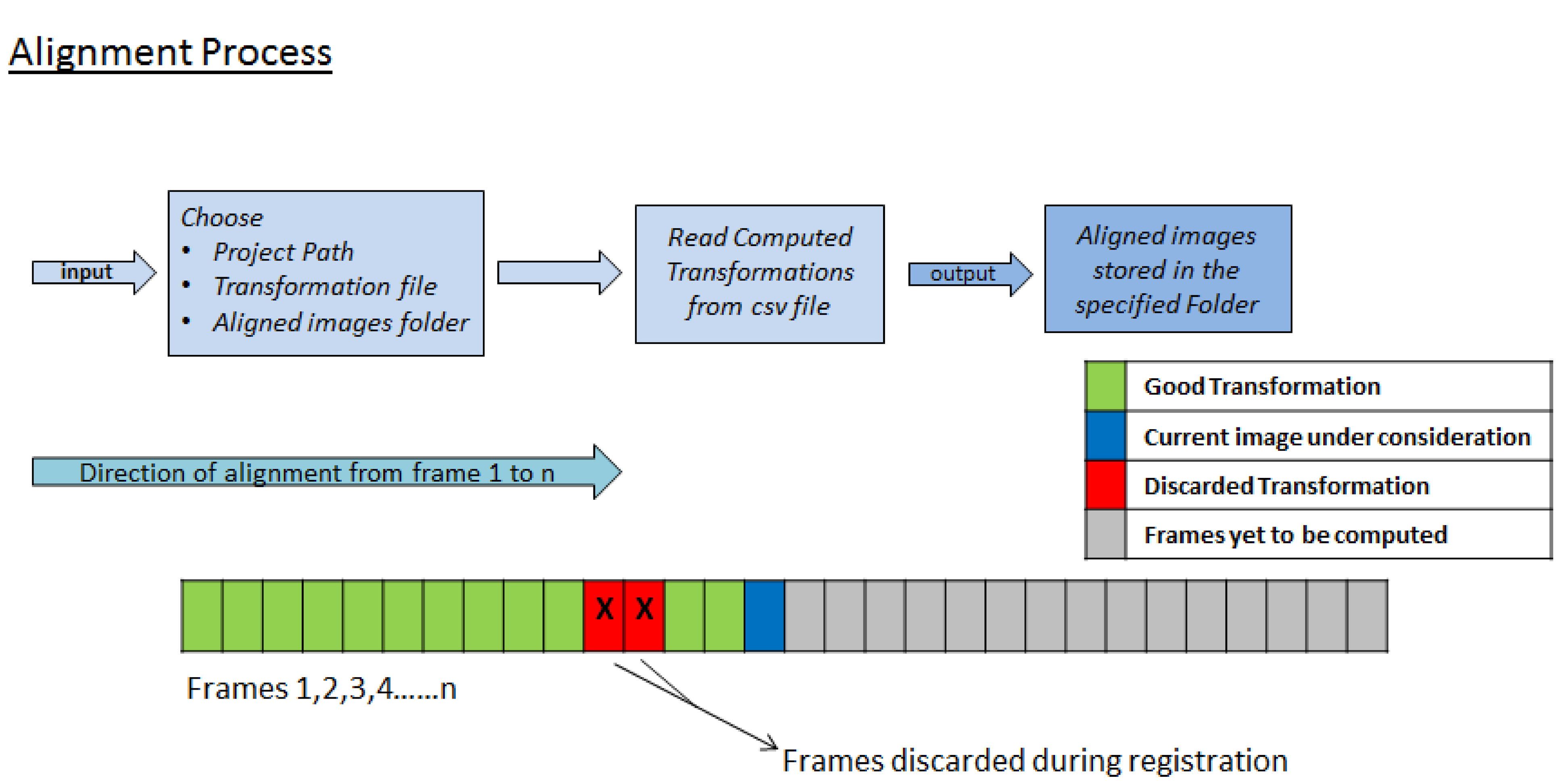
Feedback 2 Chart showing the computed transformation.



Feedback 3 Trajectory drawn on the reference image to illustrate the computed transformations.

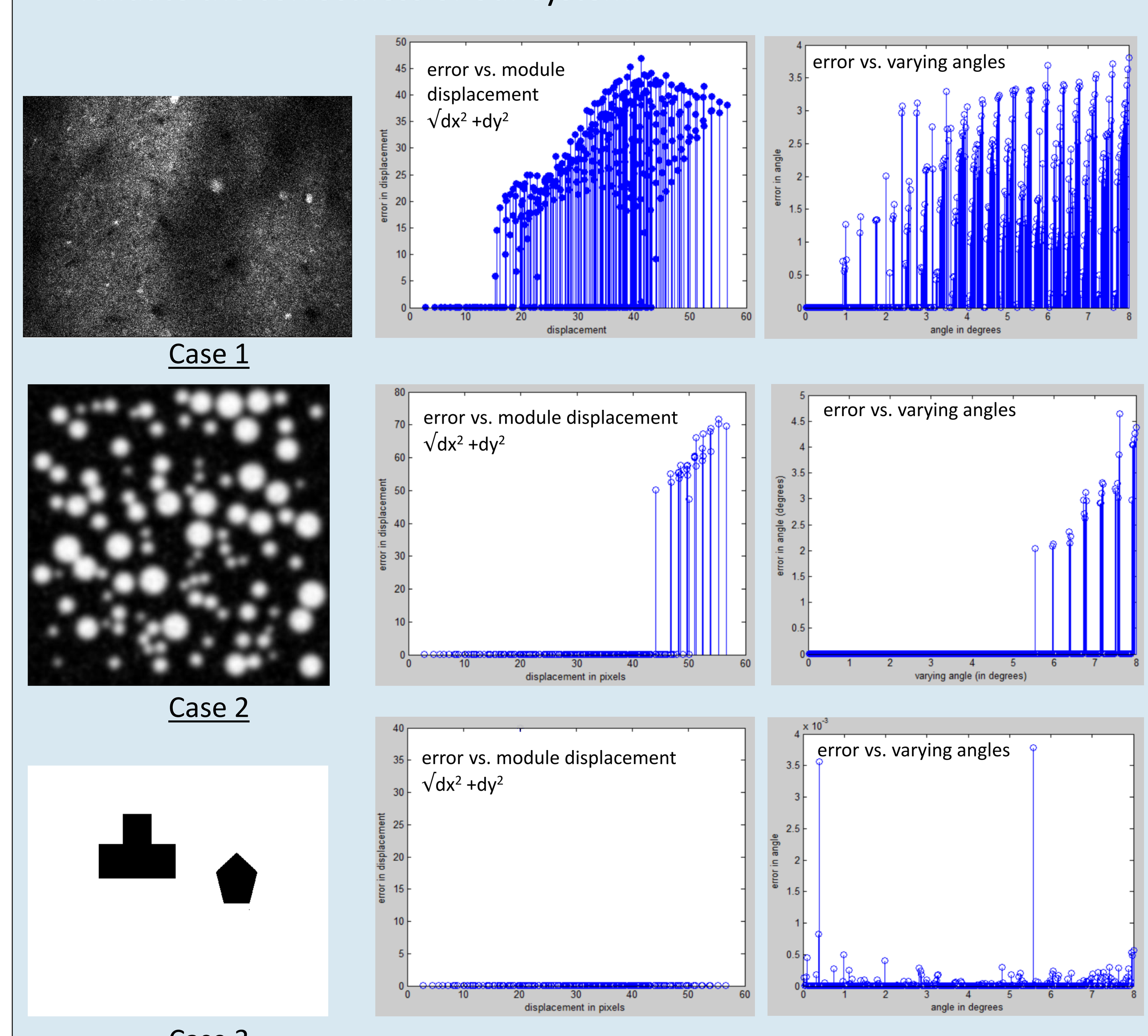






Testing / Validation

- We validate the performance of our system, we take into account 3 different cases to compute the transformations
  - ❑ Case 1: A noisy dataset – difficult to compute
  - ❑ Case 2: A less noisy image easier to compute
  - ❑ Case 3: noise free very easy to compute
- We here introduce an artificial synthetic drift in each of the 3 cases to validate the correctness of our system.



We see minimum error is observed for case 1 and maximum for case 3 as the level of noise is maximum in case 3 and no noise in case 1.

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References

P. Thévenaz, U.E. Ruttimann, M. Unser, "A Pyramid Approach to Subpixel Registration Based on Intensity," IEEE Transactions on Image Processing, vol. 7, no. 1, pp. 27-41, January.