Daniel Illner
888013562

5.1.2020

Medical Image Processing - Solution Homework 04

Rigid Registration

Part 1 – Point and image based registration algorithms

Task A - 1.

Implemented the functions *plotting_pairs(BLPoints, FUPoints)*, *plotting_points(image, pointset)* and *pickCO(dataarray, row)* here. Running *plotting_pairs(BLPoints, FUPoints)* for the results following:

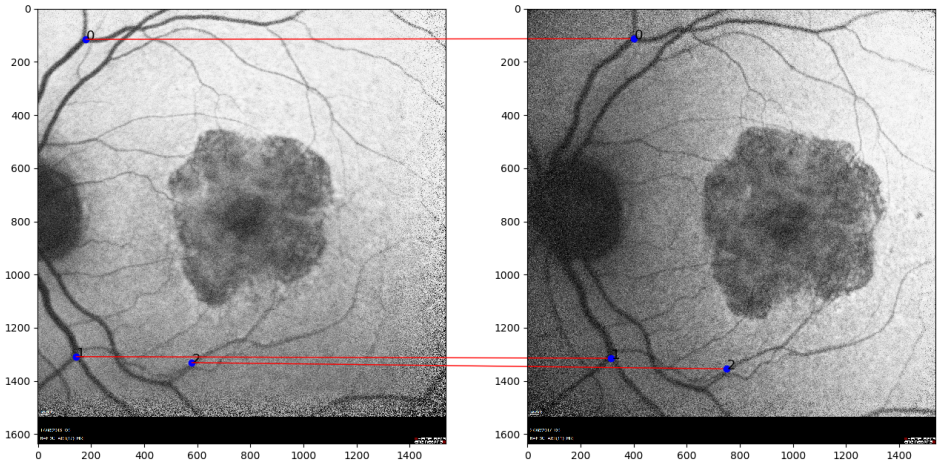


Figure 1: no outliers - 0 wrong matches

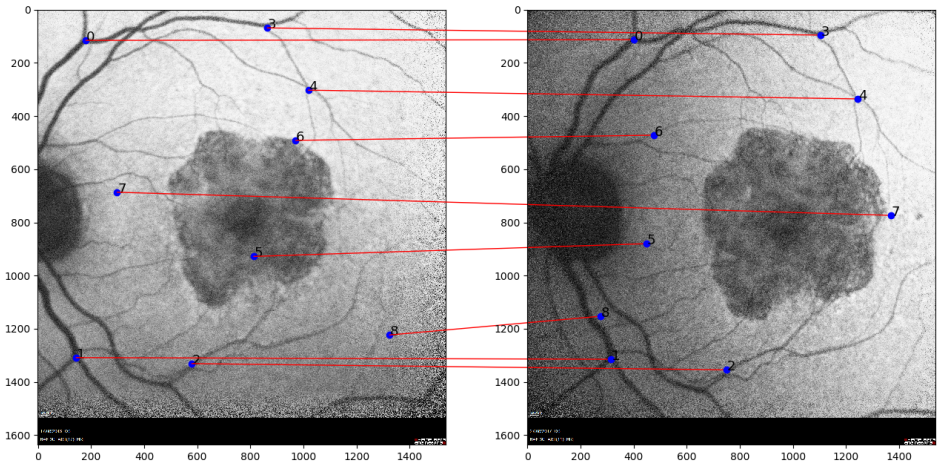


Figure 2: with outliers - 4 wrong matches (5, 6, 7, 8)

Task A - 2.

Implemented the function *calcPointBasedReg(BLPoints, FUPoints)* here. Check the code for more information and validation.

Task A - 3.

Implemented the function *calcDist(BLPoints, FUPoints, rigidReg)* here. Check for the code for more information and validation. The result by running the function is:

$$rmse = \begin{pmatrix} 5.14 \\ 2.95 \\ 2.20 \end{pmatrix} (px) \tag{1}$$

Task A - 4.

Set up the *class PointbasedReg()* in this context and implemented the function *affineTransformation(self, plot=True)* for creating the warp image. Check for the code for more information and validation. The result by running the function is:

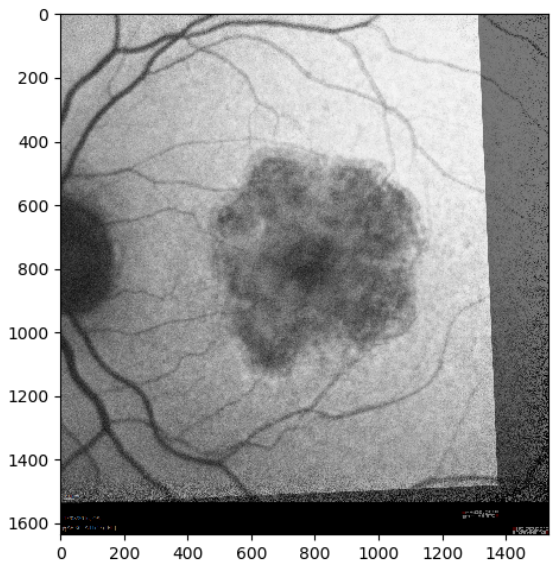


Figure 3: Warped FU image on top of the BL image - 'no outliers'

Task A - 5.

The result for the rmse by running the function with outliers is:

$$rmse = \begin{pmatrix} 738.4 \\ 480.8 \\ 130.7 \\ 214.5 \\ 485.4 \\ 45.6 \\ 67.0 \\ 210.7 \\ 292.8 \end{pmatrix} (px) \tag{2}$$

The result for the warped image by running the function with oultiers is:

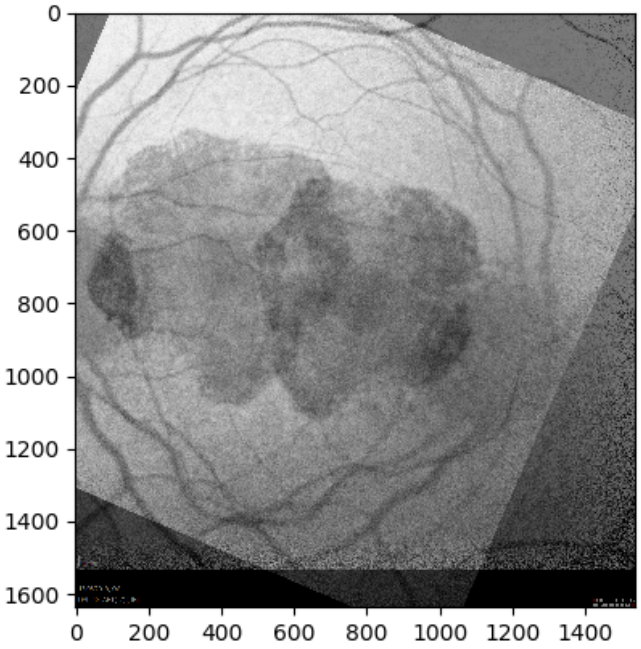


Figure 4: Warped FU image on top of the BL image - 'with outliers'

As you can see the images are not properly registered. The transformation matrix gets effected to much by taking the 4 wrong point pairs into account. So you basically need either more correct matching point pairs to overcome the effect of the 4 wrong point pairs or you need a more robust method.

Task A - 6.

By applying RANSAC on it you get:

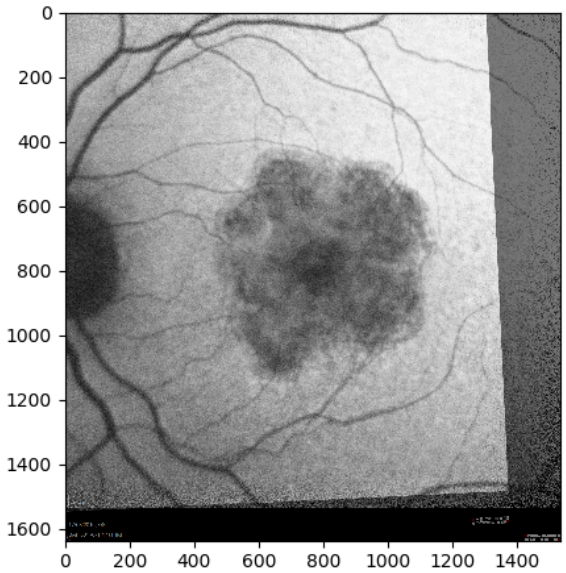


Figure 5: RANSAC: Robust Warped FU image on top of the BL image - 'with outliers'

The result for the rmse by running the RANSAC function with outliers is:

$$rmse = \begin{pmatrix} 7.00 \\ 6.70 \\ 4.73 \\ 8.17 \\ 6.22 \\ 396.84 \\ 501.13 \\ 615.31 \\ 871.03 \end{pmatrix} (px) \tag{3}$$

and found inliers $[0, 1, 2, 3, 4]$.

Part B

Find Features)

Implemented the function *findRetinaFeatures(image)* here and the result is the following:

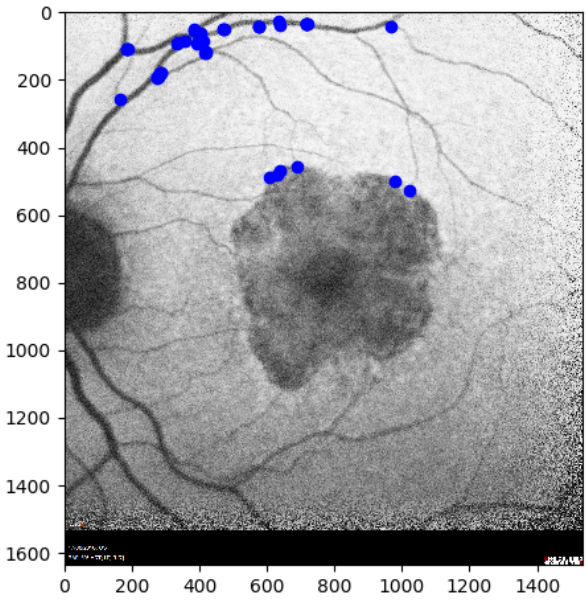
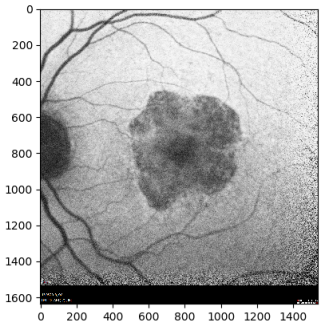


Figure 6: Found 50 keypoints by using ORB in BL image.

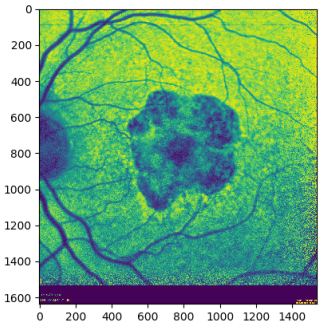
I have to add, that this is very gerneral because there were no further informations given in the exercise sheet. The function could be easily expanded by different keypoint extraction and description methods. Also more information is needed in order to pick the keypoints that are useful the most for further steps.

Segmentation of the blood vessels)

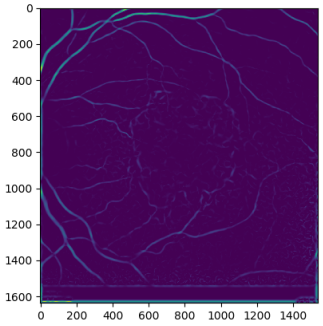
Implemented the function *segmentBloodVessel(image)* here. The result shows the different steps of the segmentation process.



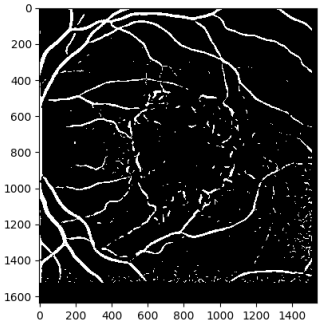
(a) BL01 - original image



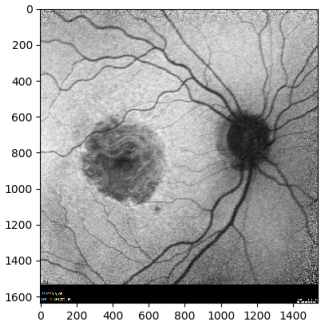
(b) BL01 - enhanced image



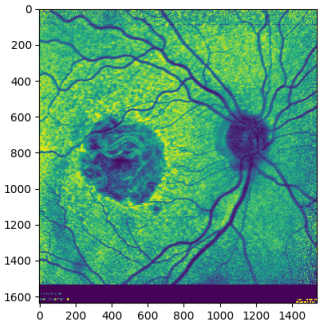
(c) BL01 - frangi filterd image



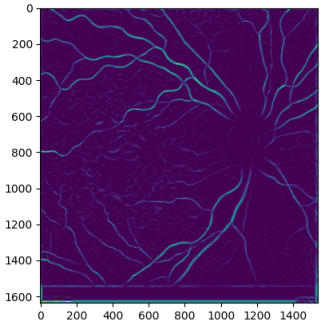
(d) BL01 - segmented image



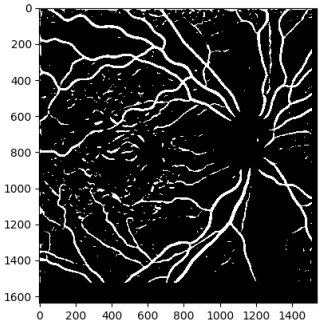
(a) BL03 - original image



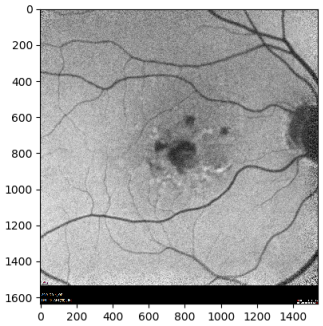
(b) BL03 - enhanced image



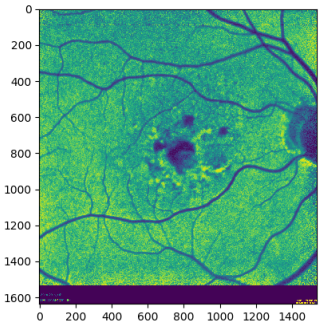
(c) BL03 - frangi filterd image



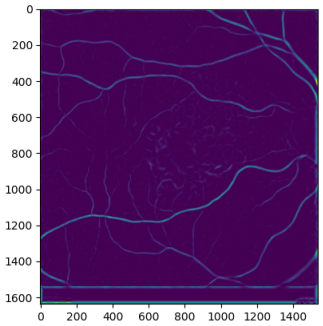
(d) BL03 - segmented image



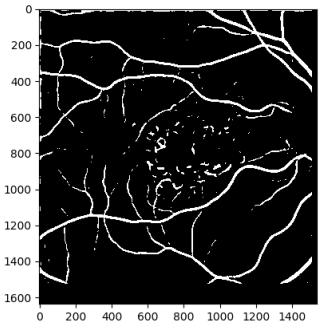
(a) BL05 - original image



(b) BL05 - enhanced image



(c) BL05 - frangi filterd image



(d) BL05 - segmented image

For details of the steps look at the code. I oriented myshelf on this paper "Oluwatobi, Akande & Abikoye, Oluwakemi & Kayode, Aderonke. (2019). Automatic Segmentation of Retinal Blood Vessels of Diabetic Retinopathy Patients using Dempster-shafer Edge Based Detector." Especially for the preprossecing steps.

To be honest, I was not sure how sophisticated the method should be. Normally in this context, I would go for the U-net, which is propably the state-of-the-art for this certain problem and gives you a more robust result (you can use Tranfer Learning in order to get the training dataset.). Anyways I hope the results are sufficient to get the points.