Medical Image Processing 67705
Exercise 5: Automatic registration and changes detection.

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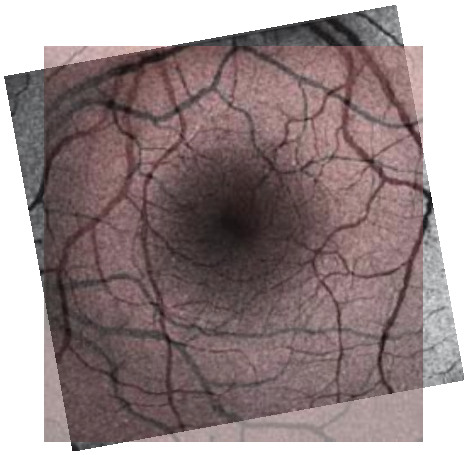


In this exercise you will implement rigid registration of 2D retinal scans. Basically, you will get several cases which comprise of a patient's baseline (BL) and follow-up (FU) scans, and you'll need to register the FU to the BL.

For this exercise, you may assume that both images in every case are of the same size and resolution and are isotropic.

You may use functions from the utils.py.

Submission

Write a report in a single pdf file called Ex5_part[#].pdf and your code in a Ex5_part[#].py file. Submit through the Moodle web page a single ZIP archive called [id]_ex5.zip.

Your report should include the answers to all the questions of the exercise as well as images of your results. Make sure to write clear answers and pay especial attention the graphs you crate: all graphs should have a title, a label for each axis, and be in the correct scale. Make sure to write in the report your name, id and CS user name. Note that **10% of the grade** is for clear and readable submission. Late submissions will be penalized by **10 points** per day.

Part 1 (45%)– Registration by features

The goal of this task is to perform an automatic registration between two ophthalmology 2D images using features.

In your previous exercise you were requested to implement 2 functions.

1. SegmentBloodVessel(Image) – perform segmentation of the blood vessels in the retina. You may assume the atrophy in the center (this is the AMD atrophy, marked by the X in the image below) is not part of the segmentation, and the caption at the bottom can be removed.
2. FindRetinalFeatures(Image) – The function will find strong features in the image to use for registration. You can use algorithms like SURF, SIFT and ORB.

Develop 2 registration algorithms first by using FindRetinalFeatures and second by using SegmentBloodVessel.

Each registration algorithm should work on at least **two** cases from here.

The steps for the both automatic registration methods are described below, but you are **encouraged** to develop and implement an algorithm of your own.

First algorithm **(20%)**, implement using FindRetinalFeatures:

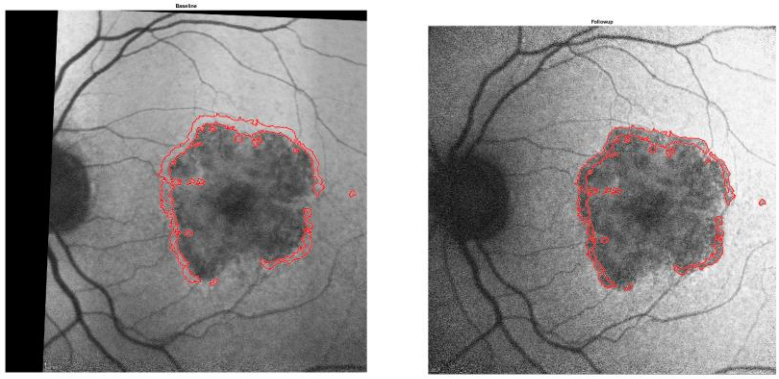
1. Features detecting- You can use ORB, SURF or SIFT
2. Features matching – You can use Brute-force
3. Pick matched points – you can use Ransac, KNN
4. Registration using code from your previous exercise.

Second algorithm **(25%)**, implement using SegmentBloodVessel:

1. Rotate one of the segmentations.
2. Perform cross-correlation between the two segmentations.
3. Find the maximum cross-correlation result.
4. Perform 1-3 until you find the global max cross-correlation, the global maximum score of the cross- correlation will be the rotation variable.

Part 2 (45%)– Detect the changes

The goal of this task is to detect the changes of the lesions between two registered ophthalmology 2D images as you can see below. On the left we can see a baseline image with the changes in the red and on the right, we can see the follow-up image with the changes in red.



Baseline image *Follow-up image*

You are required to perform the detection on at least **two** cases from here.

The following algorithm is only a proposal and you are encouraged to develop and implement an algorithm on your own.

1. Normalize both images by columns.
2. Subtract FU from BL after registration
3. Remove all pixels that are above 0 and take the absolute value of the results
4. Use some threshold method to remove some of the noise, without removing the lesion region.
5. Use skimage.segmentation.clear_border to clean noise touching the boundary.
6. Remove small objects.
7. Remove Blood Vessels.
8. Morphologically close
9. Draw the borders/polygons

Explain in detail in the report the output of each step in the algorithm you implemented and notice that you are not required to perform perfect results, only the best you can.