COMP 2047 Coursework 2021-2022

This is the assessed coursework for IIP. It is worth **40%** of the final mark.

Deadline: 16:00, April 22, 2022.

Task Description and Guidelines

Special note: put **random.seed(0)** at the beginning of each of your main functions.

Task 1: Image enhancement. (**20 marks**)

Requirements & Guidelines

- Given 3 distorted images of lena, apply a combination of the image processing techniques below on the distorted images. (Sometimes you may only need to use one technique.)
  - ❖ Gaussian filter.
  - ❖ Median filter.
  - ❖ Anisotropic diffusion filter.
  - ❖ Bilateral filter.
  - ❖ Intensity transform.
  - ❖ Other image processing techniques.
- Expected results.
  - ❖ Find the combination of techniques that produce a filtered image with maximum Signal-to-Noise-Ratio (SNR), where SNR is calculated as follows:

$$SNR = \frac{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}(f'(x,y))^2}{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}(f'(x,y)-f(x,y))^2}$$

where $f'(x,y)$ is the filtered image and $f(x,y)$ is the clean reference image. The final SNR should be reported in terms of dB, e.g.

$$SNRinDB = 10log_{10}SNR.$$

In this task, $f(x, y)$ is the clean gray-level image of lena, and $f'(x, y)$ the filtered image.

- ❖ Record down the SNRs for different filters on three distorted images in the following table. You should also show the resulting images in your report.

Image	Best SNR in DB	Brief summary of image processing techniques applied, including key parameters.
Image1.bmp	(2 **marks**)	(2 **marks**)
Image2.bmp	(2 **marks**)	(2 **marks**)
Image3.bmp	(2 **marks**)	(2 **marks**)

Table 1: SNRs for three distorted images at optimal filter parameters.

- ❖ From the image visual quality and SNRs in Table 1, justify the combination of techniques you applied. Use the experimental results and knowledge you learn from IIP to support your analysis.

- You must implement one main function that calls other functions to generate all the results, e.g. **Task1.ipynb.**
- **Hint: You may compare the image characteristics of the clean image and the noisy image to find the combination of techniques.**

Marking Criteria

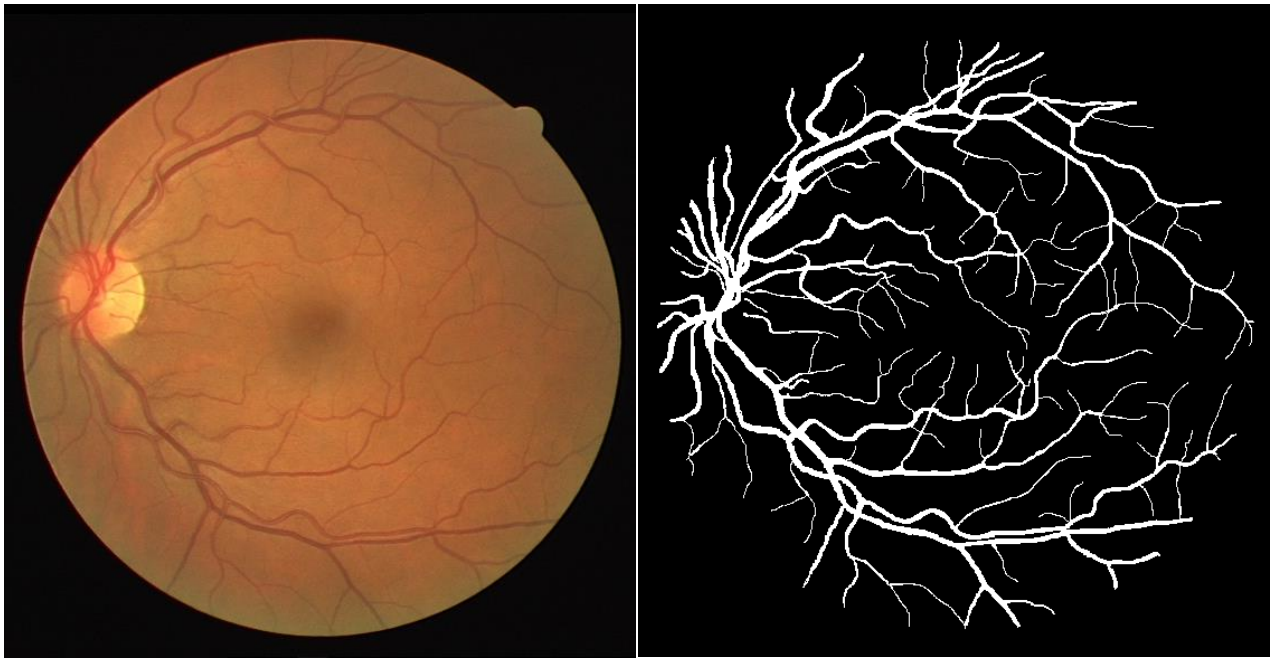
You should include Table 1 in your report. Marks will be given by considering:

- Whether the derived SNRs in Table 1 are close to the optimal values. (6 **marks**)
- Whether the combination of techniques in Table 1 is reasonable. (6 **marks**)
- Whether your designed techniques for each distorted image are reasonable and clearly justified. (6 **marks**)
- Whether your codes follow good programming practice. (2 **marks**)
- It is important to well document your code. Code without comments may receive a maximum deduction of 5 marks!!!
- **You can use existing filter implementations or toolbox developed by others, but you need to provide a proper reference. You are reminded of the school policy on plagiarism when using others' code without a proper reference.**

Task 2: Segment the retina blood vessel. (**20 marks**)

Retina blood vessel segmentation is challenging. Given the image on the left, it is very difficult to accurately segment the blood vessel as shown on the right, especially the thin ones. You are free to design your own algorithm to segment the blood vessel, down to per pixel level.

NOTE: You are not required to achieve the state-of-the-art results, but you should achieve satisfactory results.



Requirements & Guidelines

- You should **test your algorithm on "Retina.tif" only**, and show the segmentation results for this image. You should **never** use "**Label.png**" when you design your algorithm, where the label images indicates where the blood vessel is and should only be used in evaluating the accuracy of your program. The mask image ("**Mask.png**") masks out the background of retina image. You are suggested to design a filter-based method, not a machine-learning-based method.
- When test your algorithm, you should compare the segmentation results of your algorithm with the ground-truth image ("**Label.png"**). You should report the following:
  - The percentage of **blood vessel** pixels that is being correctly classified as **blood vessel**. Denoted as P.

- ❖ The percentage of **background** pixels (**only consider the region in the mask**.) that is being correctly classified as **background**. Denoted as N.
- ❖ The percentages of pixels are being correctly classified. (**only consider the region in the mask**). Denoted as T.
- ❖ For example, assume in the mask we have 100 pixels, 10 pixels are retina and 90 pixels are background. The segmentation result is that 12 pixels are retina (only 8 are true retina and 4 are false retina) and 88 pixels are background. (only 86 are true background and 2 are false background.) Then P = 8/10 = 80%; N = 86/90 = 95.56%; T = (8+86)/100=94%.

- You may consider the following filters. It is up to you to choose which one to use. You may use other filters if appropriate. **You can use FILTERS from internet resources, with proper acknowledgement**. You should **NOT** use the complete (or near complete) solutions you may find from internet resources.
  - ❖ Laplacian of Gaussian filter.
  - ❖ Difference of Gaussian filter.
  - ❖ Canny filter.
  - ❖ Match filter.
  - ❖ Gabor filters.
  - ❖ Other filters.
- You may directly process the filtered images to obtain the per-pixel classification results of the retina image, or you may try to combine the results from several filters.
- A sample code is provided, which gives an accuracy of T = 89.8%. You are expected to do better than this.
- When discussing the pros and cons of your algorithm, you should compare it against other possible solutions.
- You should implement everything in one file, e.g. **task2.ipynb**.

Marking Criteria

You should include the explanation of your algorithm, the intermediate results and the final results in your report. Marks will be given by considering:

- The quality of your per-pixel level segmentation results. You should try to maximize T. (**6 marks**)
- The explanation and justification of your algorithm. (**8 marks**)
- Discuss advantages and disadvantages of your algorithm. (**4 marks**)
- Good programming practice. (**2 marks**)
- It is important to well document your code. Code without comments may receive a maximum deduction of 5 marks!!!

Plagiarism

You are reminded of the School's Policy on Plagiarism. We will run the plagiarism check on both the code and the report.

Report

There is no strict page limit of the report. Preferably the maximum number of pages is 15. Font size 12. All images on the report should be large enough for visual inspection of the image quality.

Late submission

The standard late submission policy applies, i.e. 5% deduction of the total mark for every 24 hours. (including weekends, holiday.)

How to submit

Online submission via Moodle. You should zip all the python files, the PDF file of your report in **ONE** zipped file. (**You do not need to submit the resulting image files, but your program should show the resulting images with proper caption. In your report, you should clearly explain how to run your code.**)

You should name the zip file using your name and student ID, e.g. “DongChen_1234567.zip”. Please note that every next submission overwrites the files in the previous one, so if you submit several times, make sure that your **last submission includes all the necessary files, can be unzipped and executable**.

You do **NOT** need to submit the hardcopy of your report to the faculty office.