Bauhaus-Universität Weimar

Assignment 1

Submission Deadline: 30.04.2025

Based on a satellite image (`input_sat_image.jpg`) of low contrast, you are supposed to **extract the water surfaces** in the city area. That is, water surfaces are to be treated as the foreground, while all other surfaces represent the background of the image.
For your solutions, you are allowed to use the provided helper functions (`utils.py`) and **only** the modules specified in the introductory slides.

Task 1) Image Enhancement

Implement a function to **enhance the contrast** of an image. For that purpose, first convert your color image into a grayscale image (`Image.open, mean, rgb2gray`, …).

a. Visualize the initial image and the corresponding *histogram* (`plt.imshow, plt.hist`).
b. Shortly describe the characteristics of the histogram.
c. Enhance the image using *contrast stretching* (provide **self-written code;** `np.min, np.max` are allowed).
d. Shortly describe the differences to the initial histogram.
e. Visualize the resulting enhanced image.

Task 2) Binarization

Write a function for **thresholding** the enhanced image of **Task 1)**

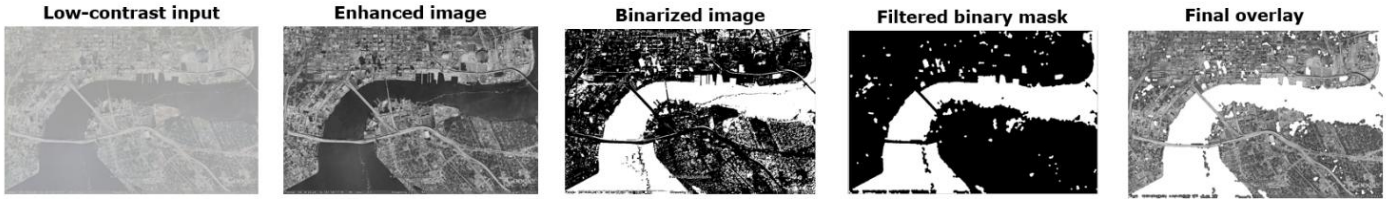
a. Convert the enhanced image to a *binary mask*, where 0 = **background** and 1 = **foreground**, i.e. water surfaces in `input_sat_image.jpg`
b. Visualize the resulting binary mask
c. Test a number of different threshold values and describe the effects. Did you experience any difficulties while searching for an appropriate threshold value?

Task 3) Morphological Operators

Write a function for **morphological filtering** of the binary mask obtained in **Task 2)**

a. **Successively** apply morphological *opening* and *closing* on the mask (`imopen`, `imclose`).
b. Visualize an overlay of the contrast enhanced image and the final filtered mask.
c. Write a main function which sequentially executes the functions from Task 1 to 3.
d. Are the results satisfactory? What are the limitations of this approach for foreground-background separation?
e. Test your program with a **different low-contrast input image** of your choice. Do you notice a significant difference with respect to quality of the results for the different input images?

Sample results based on `input_sat_image.jpg`:



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