

# Image and Video Processing (Spring 2025)

## Assignment 3: Frequency Domain Processing

Apr 25, 2025

### 1 Gaussian Filtering [10 points]

Implement Gaussian filtering both in the spatial and frequency domains and demonstrate that convolving an image with a Gaussian filter with standard deviation  $\sigma_s$  in the spatial domain is equivalent to point-wise multiplication in the frequency domain with Gaussian filter with standard deviation  $\sigma_f = \frac{1}{2\sigma_s\pi}$ .

As a test image for this exercise, create an image similar to the one shown in Figure 1. For filtering both spatial and frequency domains assume padding with zero values. In the report, please show examples of filtered images with different pairs of  $\sigma_s$  and  $\sigma_f$ . Also, analyze how the performance of equivalent filtering in spatial and temporal domains depends on the parameter  $\sigma_s$ . In particular, include in your report a plot of the execution time for both domains as a function of  $\sigma_s$ .

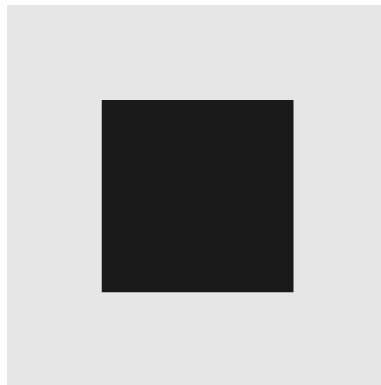


Figure 1: An input image for the exercise 1.

### 2 Image Restoration [10 points]

Consider a task of removing a repetitive pattern from an image using filtering in the frequency domain. Figure 2 demonstrates an input and the corresponding output of such a procedure. Design and implement a filtering procedure which perform such restoration. Explain your technique, show Fourier plots of all the steps, as well as the final image. Use the input image provided with the assignment.

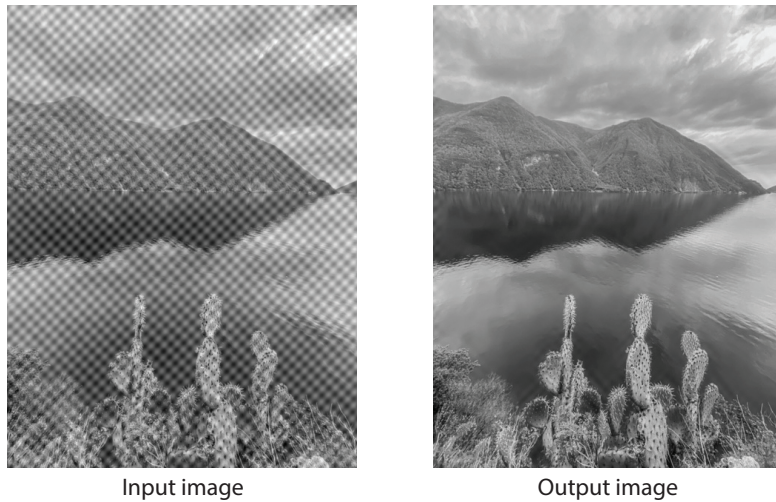


Figure 2: Input and output images from exercise 2.

## Submission

You should submit your Live Script/Notebook with the report inlined as described below. Name the file as `surname1_name1_surname2_name2_assignment3.mlx/.ipynb`. Please follow these guidelines:

- You can only use basic functions (matrix operations, input/output image functions, plotters). Anything else, you need to code from scratch (histogram functions, inverting gamma functions, color matting, histogram equalization).
- The code needs to be appropriately commented and should be reproducible; if we cannot re-generate your figures from your code, we will deduct points.
- The Script/Notebook Report should be detailed and include partial and final solutions for each exercise. We grade solely the Report part; Code without report will not be graded, so we encourage that you invest some time on it.
- Interactive plots are welcome, but most important results should be static and generated beforehand.
- Remember to remove all plots and output from the Task sections. Only the Report should output plots and/or images.

Grading will be **solely** based on the provided report, so we encourage clarity and detailed answers. Usage of ChatGPT or any other natural language model is strictly prohibited and will be severely punished.

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**Solutions must be returned on May 7, 2025 via iCorsi**