Università della Svizzera italiana

Faculty of Informatics

Image and Video Processing (Spring 2024)

Assignment 3: Frequency Domain Processing

Apr 18, 2024

1 Gaussian filtering [10 points]

Implement, in MATLAB, Gaussian filtering both in the spatial and frequency domains and demonstrate that convolving an image with a Gaussian filter with standard deviation σ_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, use an image similar to the one shown in Figure 1. Use MATLAB to construct such an image with size 1024×1024 pixels. 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 σ_s and σ_f.
BONUS (1 point): Use MATLAB `tic` and `toc` functions to analyze how the performance of equivalent filtering in spatial and temporal domains depends on the parameter σ_s. In particular, include in your report a plot of the execution time for both domains as a function of σ_s.

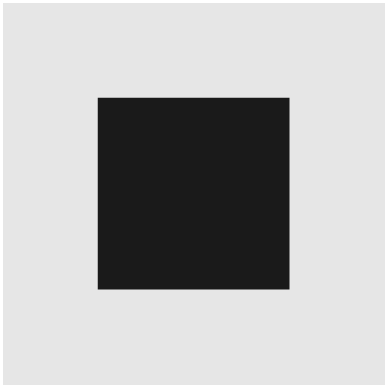
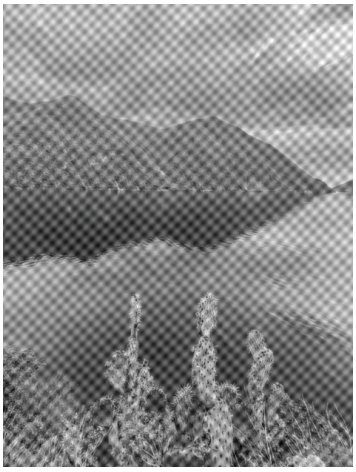


Figure 1: An input image for the exercise 1.

2 Image Restoration [10 points]

Consider the 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.



Input image

Output image

Figure 2: Input and output images from exercise 2.

Submission

You should submit one ZIP-file via iCorsi containing:

- All your code in MATLAB appropriately commented, and the processed pictures that you obtained.
- A complete PDF report detailing your solution and partial results.

Grading will be mostly based on the provided PDF report so we encourage clarity and detailed answers. We recommend using LaTeX or Overleaf to write the report. Usage of ChatGPT or any other natural language model is strictly prohibited and will be severely punished.

Solutions must be returned on May 8, 2024 via iCorsi3