



Imagerie Numérique

Frequency domain filtering

TP Class N° 12

May 21, 2021

Exercise 1. Lowpass Filters (1.5 point) **obligatory exercise**

Take a grayscale image *lena* and add to this image the zero-mean white Gaussian noise with a standard deviation $\sigma = 20$.

- (a) Perform the image denoising in the time domain by applying the Gaussian filter.

Similar exercise you performed in the TP6 (ex. 2).

- (b) Perform image denoising in the Fourier domain by applying:

- Ideal Lowpass Filter;
- Butterworth Lowpass Filter;
- Gaussian Lowpass Filter;

Determine the suitable filters' parameters by yourself to obtain the best MSE.

- (c) Visualise the image before and after denoising. Compare and explain the denoising quality in (a) and (b) based on *MSE*.
- (d) What are the advantages / disadvantages of the lowpass filtering in the Fourier domain compared to the corresponding filtering in the time domain?

Exercise 2. Image Sharpening (1.5 point) **obligatory exercise**

Take a grayscale image *lena*. Blur this image with the box filter of size 3×3 .

- (a) Perform the image sharpening in the time domain using the Gaussian or Laplacian filter.

You can use your results obtained in the TP6. ex. 5

- (b) Perform the image sharpening in the Fourier domain using any of the following filters:

- Ideal Highpass Filters
- Butterworth Highpass Filters
- Gaussian Highpass Filters
- The Laplacian in the Frequency Domain
- Unsharp Masking, Highboost Filtering, and High-Frequency-Emphasis Filtering
- Homomorphic Filtering

Determine the suitable filters' parameters by yourself.

- (c) Visualise the image before and after sharpening. Compare (a) and (b) and explain the obtained results.
- (d) What are the advantages / disadvantages of the image sharpening in the Fourier domain comparing with the sharpening in the time domain?

Exercise 3. Image Selective Filters (1 point for each image)

You are given a set of images *img_001* - *img_004*.

- (a) Perform the image enhancement by image selective filtering (Bandreject, Bandpass, Norch filters). Please, choose the most suitable filter for each image. Justify your choice.

Hint: Theme 8, page 56.

- (b) Visualise
- the image Fourier magnitude before and after filtering;
 - the image in the time domain before and after filtering.
- (c) Describe what kind of filtering and with what parameters you used.
- (d) Can you estimate what kind of filtering should be performed in the time domain to obtain the similar result? Explain how would you design such a filter.

Exercise 4. Moire Pattern Suppression in Radiographs (1 point) **obligatory exercise**

This exercise aims at studying how to reduce Moire patterns by filtering in the Fourier domain. You are given the images *img_005.jpg* and *img_006.jpg*. Each of these images is corrupted by a clearly visible Moire pattern.

For any of these images:

- (a) apply an $N \times N$ median filter. Adjust the window size N so that the Moire pattern is removed as much as possible while salient features are properly preserved. Report your choice of N , display the original and filtered images and comment the quality of the filtered image.
- (b) perform the image enhancement by filtering in the Fourier domain. Describe what kind of filtering and with what parameters you used. Display the original and filtered images and comment the quality of the filtered image.
- (c) Compare the result in (a) and (b). Make a conclusion about the efficiency of each type of filtering.

Submission

Please archive your report and codes in “Name_Surname.zip” (replace “Name” and “Surname” with your real name), and upload to “Assignments/TP12: Frequency domain filtering” on <https://moodle.unige.ch> before **Friday, June 4 2021, 23:59 PM**. Note, **the assessment is mainly based on your report, which should include your answers to all questions and the experimental results.**