Lab session of Image Analysis

BE 3. Image filtering, edge detection, object detection

Data Duration: 2h.
The material of this lab session can be found on **Chamilo**.

Instructions Submit a **report** for each group (binome) of the session in a unique **pdf**, name it **`LabX_Name1_Name2`**, with **`X`** the number of the lab session and **`Name1,2`** your surnames. Upload it in the folder corresponding to your group and lab in **Chamilo**

Deadline submission The material report should be submitted within a week from the lab work. The preparation has to be done individually and will be collected at the **beginning** of the lab.

Note you can use the command `addpath('images')` to add the folder `'images'` to the search paths Matlab looks into when calling `imread` and other such commands.

Objectives The objectives of this lab work are:
- Evaluate the performances of image denoising
- Object detection by phase correlation

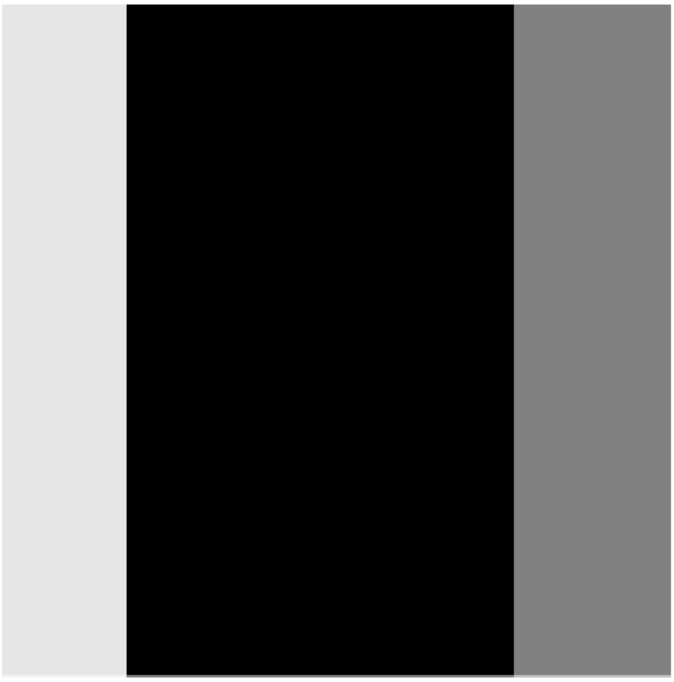

Figure 1: .

Preparation

- What is the histogram of an image? Draw the histogram of the Fig.1
- Represent 3 new histograms of Fig.1, each obtained after adding different type of noises (Gaussian, salt and pepper, uniform).
- What techniques would you use to denoise these images?

1 Noise filtering

To evaluate the performances of image denoising, we artificially add noise to images and try to remove it. This way, we can compare the denoised image to the reference one.

1.1 Noise simulation

- Add Gaussian noise to the images *cameraman*, *baboon* and *cafe*.
  Note: use `Inoisy=Iin+sigma*randn(size(Iin)`, where `Iin` is the input image and `sigma` the standard deviation of the noise.
- Comment on the image histogram before and after adding noise, with different values of the noise level `sigma`.
- Add salt & pepper noise to the image with the instruction `Inoisy2=imnoise(Iin,'salt & pepper',dens)`, where `dens` represents the noise density

1.2 Denoising

For each of the two noisy image of prevous section perform the following operations:

Mean filtering The simplest way to denoise an image is by linear filtering, and the simplest linear filter is the mean filter, with all its coefficients equal (use `imfilter`, and `ones` to create the filter).

- Recall the principle of mean filtering.
- For each of the three noisy images (with `sigma=20` and `dens=0.2`), find the size of the mean filter which provides the best image after filtering.

Median filtering

- Recall the principle of median filtering.
- For each of the three noisy images (with $sigma = 20$ and $dens = 0.2$), find the size of the median filter which provides the best image after filtering. (use `medfilt2`).

1.3 Quality assessment

For the above denoising procedures, assess the "objective" quality of the image by comparing the original I_{in} and the denoised image I_{den} through PSNR; we remind here its definition:

$$PSNR = 10\log_{10}\left(\frac{d^2}{MSE(I_{in}, I_{den})}\right) \tag{1}$$

where d is the maximum possible value of the image ($d = 255$ for 8-bit images) and MSE represents the mean square error among the two images. What are the possible disadvantages of using this quality index?

2 Edge detection

- How would you find the edge of an image ?
- Get the magnitude of the gradient of the images *cameraman*, *baboon* and *cafe*, using the Sobel filters (in the horizontal and vertical direction; then take the mean square of the two results to summarize the results in both directions)

3 Object detection by phase correlation

Open the image *tokens.tif* as I_{in}. The goal is to detect the position of tokens, specifically a black image with a white dot at the center of each token. For this, implement the phase correlation method using a simulated disk I_d as the element to detect. We briefly recall here that the requested map R may be obtained as:

$$R = \mathcal{F}^{-1}\left\{\frac{\mathcal{F}\{I_{in}\}(\mathcal{F}\{I_d\})^*}{|\mathcal{F}\{I_{in}\}(\mathcal{F}\{I_d\})^*|}\right\}$$

where $\mathcal{F}\{.\}$ is a Fourier transform, $\mathcal{F}^{-1}\{.\}$ its inverse, * is the complex conjugate and $|.|$ a module oparation. Mathematically, why does this operation perform a phase correlation?