Assignment 4

Submission Deadline: 18.06.25, 11:00 pm

Topics:

- Filtering in frequency domain
- Shape recognition using Fourier descriptors

A) Image filtering in frequency domain

a. Read the input image `taskA.png` and convert it to a grayscale image (double values between 0.0 and 1.0).
b. Add Gaussian noise to the image (e.g. parameters: mean=0, variance=0.01) and plot the result.
c. Filter the noisy image with a **self-computed** 2D Gaussian filter in the frequency-domain (`fft2, ifft2`). Which σ is suitable to remove the noise? Plot the result.
d. Plot the logarithmic centered image spectra of the noisy image, the (padded) Gaussian filter and the filtered image (`log`, `abs` and `fftshift`)

B) Shape recognition using Fourier descriptors

a. Read the image `trainB.png` and convert it to a grayscale image (double values between 0.0 and 1.0)
b. Derive a binary mask of the image where 1 represents the object of interest and 0 represents background (you may use built-in thresholding functions).
c. Build a Fourier-descriptor D_f based on the binary mask of b.
    i. Extraction of boundaries of the binary mask (you could use, for example, `measure.find_contours` from the scikit-image library).
    ii. Use $n = 24$ elements for the descriptor.
    iii. Make the descriptor invariant to translation, orientation and scale.
d. Apply steps a.-c. on the images `test1B.jpg`, `test2B.jpg` and `test3B.jpg` in order to identify all potential object boundaries in the images. Note that more than one boundary will be identified in the test images.
e. Identify the object of interest by comparing the trained Fourier-descriptor (result of step c) with all identified descriptors of the test images from step d. Use the Euclidean distance of the Fourier-descriptors for identification, i.e.

$$\mathrm{norm}\left(D_{f,train} - D_{f,test}\right) < 0.09$$

f. Plot the identified boundaries on your mask (result of task b.) in order to validate the results

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