Laboratorio di Elaborazione di Bioimmagini

Homework 2 – 21 Aprile 2012

Homework due by Wednesday, May 2nd 2012. Please upload the archive (.zip or .rar) in the dedicated Repository Homework 1 folder located in Area Consegna, CorsiOnLine. Also, please read the How to file in the Homework section. Questions can be posted on the Forum section available on CorsiOnLine.

In case of troubles, please mail enrico.caiani@biomed.polimi.it and francesco.maffessanti@mail.polimi.it.

Exercise 1

The image *h2_CT_head_corrupted.tif* is a tomographic image corrupted by at least two distinct sinusoidal interferences. The goal of the exercise is:

1) to design a band-reject filter able to filter the sinusoidal noise. Please visualize, in four different figures, the frequency response of the designed filter, the spectrum of the corrupted and restored images, as well as the restored image;
2) to design the band-pass filter able to isolate suppress everything but the noise components.

Exercise 2

Create and apply to the image *h2_PET_image.tif* the homomorphic filter shown at lesson. The following filter H should be used for filtering in the filtering domain:

$$H(u,v) = A + \frac{C}{1 + \left(\frac{D_0}{D(u,v)}\right)^B}$$

where A = 0.25, B = 2, C = 2, D_0 = min(M,N)/8 and D is the distance (in pixel unit) of the from the zero-frequency component (the spectrum is centered on the zero-frequency component), while M and N are with width and height of the image.

Visualize in seprate figures the original image, the enhanced image and the frequency spectrum of H.

NOTE: do not pad the images.

Exercise 3

Given the images *h2_test_pattern.tif* e *h2_mri_4ch.tif*, (f and g in the follow), write the Matlab script to:

1) compute the power and phase spectra of f and visualize them in two separate figures;
2) compute the inverse FFT2 using only the phase spectrum (ie **ifft2** di $e^{j\varphi(u,v)}$) and visualize the resulting image;

3) compute the inverse FFT2 using only the power spectrum and visualize the resulting image;
4) repeat the steps 1), 2) e 3) for g;
5) compute the inverse FFT2 using the power spectrum of f and the phase spectrum of g, and viceversa, visualizing the two resulting images.

On the basis of the obtained results please write a brief comment about the information content relevant to the amplitude and to the phase.

NOTE: to ensure an optimal visualization at step 3), please utilize imshow(log(1+…)).

Exercise 4

Load the file *h2_noisy_images.mat*, containing 4 corrupted images. For each image, please identify the kind of noise added to the image and its parameters (ie: frequency, amplitude and tilting for sinusoidal noise; mean and standard deviation for Gaussian noise; density for salt and pepper noise). Write a brief report describing how did you solve the exercise.

NOTE: hypothesize you are blind to the original images.

Esercizio 5

Given the image *h2_mri_4ch.tif* visualize the image and its spectrum. Moreover:

1) create two average filters (5 and 15 pixels wide), a Gaussian filter (standard deviation equale to 2) and an unsharp filter; visualize in a single figure the spectrum of the four filters;
2) aplly the created filters to the MR image and visualize in a single figure the spectra of the filtered images;
3) visualize the filtered images in a single figures.

Write a short comment about the obtained results, paying attention to the differences due to the applied filters, if any.