Medical Computer System and Analysis (1111)

Homework #2 (Due: 2022.11.07)

Please use Python or Matlab for this homework.
Please include the source codes and comprehensive report (.pdf) in your uploaded ZIP file.*

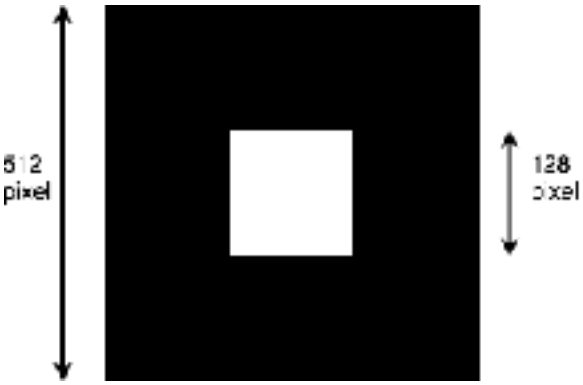
1. According to HW#1, Prob.6, a 2D Gaussian function can be expressed as:

$$f(x,y) = A\exp\left(-\left(\frac{(x-x_0)^2}{2\sigma_x^2}+\frac{(y-y_0)^2}{2\sigma_y^2}\right)\right)$$

where A is the amplitude, x_0, y_0 is the center and σ_x, σ_y are the spreads of the blob. Plot its 2D gray-level image of 512x512 pixel with A = 1, (x_0 , y_0) is the center of image, σ_x = σ_y = 30. Display their Foruier-transformed phase and magnitude images. Then compare the results with the images in HW#1, Prob.6.

2. Create two copies of an image that consists of a white square in a black background as:

   (a) Do 2D convolution on these two images in the spatial domain.



   (b) Do 2D FFT on this image and plot the result as a gray-level image with Log scale in the intensity (magnitude) and its phase.

   (c) Derive the convolution of this image with the 2D Gaussian image obtained in prob.2 (b). Explain it mathematically in your own words.

3. Assume that the EEG signal is available in digitized form, having been sampled at 50 Hz. The simulated signal ("eeg.mat" or "eeg.txt") is sampled at 50 Hz for approximately 4 minutes and contains examples of all three EEG rhythms (α, θ, δ).

   (a) Plot the simulated EEG signal in the time domain with proper time axis.

(b) Use FFT to analyze this simulated EEG signal in (a). Plot the absolute value of the spectrum with proper frequency axis.

(c) Apply some bandpass filters to the 4-minute EEG signal in order to separate these three rhythms. Display the separated EEG signals in time domain and frequency domain respectively.

4. The data file "ecg.mat" ("ecg.txt") contains an ECG signal, sampled at 200 Hz, with a significant amount of 60 Hz power-line artifact.

(a) Plot the signal in time domain with proper time label in the unit of second.

(b) Plot the absolute value of spectrum in frequency domain with proper frequency label in the unit of Hz.

(c) Try to remove the 60-Hz noise by applying ideal low-pass filter. Display the result both in frequency and time domain.

(d) Repeat (a) to (c) and apply the same filter design in (c) when sampling frequency is changed to 100 Hz. Explain the results in your words.