Classical Image Processing – Hands On

Lecture 6:

Task 1: fftshift

This code creates a wave composed of 2 frequencies and noise.

```
fs = 100;                        % Sample frequency (Hz)
t = 0:1/fs:10-1/fs;              % 10 sec sample
x = (1.3)*sin(2*pi*15*t) ...     % 15 Hz component
  + (1.7)*sin(2*pi*40*(t-2)) ... % 40 Hz component
  + (2.5)*randn(size(t));        % Gaussian noise;
```

Hz means cycles per second.

What is the sampling rate in the time domain?

How many samples are in the signal x?

Calculate the FT and show it with and without FFTSHIFT.

Task 2: the Convolution Theorem in Practice

Let’s implement the convolution theorem in the naïve way.

Take an image of your choice. Design a Low Pass Filter in the spatial domain with its size as a variable. Do not forget to normalize it.

Create a zero image in the size of your image of choice.

Embed the filter in the zero padded image. The trick here is where to place the center of the filter.

Perform FFT to both image and filter and then multiply the transforms.

Compare to the result of implementing the filter in the spatial space.

Hint:

1) make sure that the zero frequency is in the right location.

2) be careful with fftshift and ifftshift

A better way: explore the freqz function in Python and freqz2 function in Matlab.

Task 3: Design HPF and LPF

Create ideal and Gaussian LPF and HPF in the frequency domains.

Try to view the filter in the spatial domain.

This is a great opportunity to see the importance of ifftshift and taking the real values of FT.

If you actually want to view the filters, you might need also to take the log of the result.

Task 4: This can only be done in the Fourier Domain

Take an image of your choice. Perform FT and corrupt it in known points, e.g. set values to zero.

See how image looks like.

Now, try to restore the FT of the corrupted image using some averaging of neighboring values and see if a good enough restored image can be obtained.

Task 5: STFT

Find a function that does stft of signals and images and apply it with different parameters.