Image Processing I
Lab Tutorial 4
Fourier Transform

Objectives:

The main objective of this lab is to explore the Image processing Tool box given in Matlab by writing different small script and further investigates spectrum and simple filtering techniques in the frequency domain, if the effect is not clear in time domain.

Resources:

1- Lena
2- Landsat
3- sonar image
4- sar image
5- T10
6- Box

You are of course encouraged to try these programs on images of your choice, especially on your own image.

Useful Matlab Commands: imread, rgb2gray, imagesc, fft2, ifft2, imrotate, randn. In this Lab session you should look for the help of the function because I didn't write the syntax. In Matlab command window write:

Help <u>name of the function</u>

1.1 Fourier Transform and Inverse Fourier Transform:

The Fourier Transform is an important image processing tool which is used to decompose an image into its sine and cosine components. The output of the transformation represents the image in the *Fourier* or frequency domain, while the input image is the spatial domain equivalent. In the Fourier domain image, each point represents a particular frequency contained in the spatial domain image.

The Fourier Transform is used in a wide range of applications, such as image analysis, image filtering, image reconstruction and image compression.

To Try:

- *Please load an image (for example lena.tif).*

- *Display the image in a figure.*
- *Now find the (2D) Fourier transforms of the images.*
- *Use matlab's fft2() (2D Fast Fourier Transform) function for this.*
- *Use fftshift () to put the origin of the computed spectrum into the center of the plot.*
- *Use the abs () function to compute the magnitude of each (complex) frequency term before plotting.*
- *Using log () will bring out smaller values better*
- *Use the routine imagesc () for this display since your value range will be outside [0, 255].*
- *Now take inverse Fourier transform of the image (ifft command) and compare it with Original image. And write your observation.*
- *Comments?*

Try this on rest of the images e.g. sonar, sar, Box and write your comments on each of them.

As you have already seen in class, the phase of the spectrum is related to the structure of the image. Note that output of Fourier transform is an array of complex numbers stored as real and imaginary parts. real (ima_out) returns the real part while imag(ima_out) returns the imaginary part. Magnitude and phase can be obtained from the real and imaginary part using the abs and angle functions.

1.2 Phase Manipulation:

Calculates the FFT of an image, leave the magnitude unchanged but replaces the phase with random values. The inverse Fourier transform is then performed to re-create the image. Use this function to investigate the effect of the replacing the phase with random values.

To Try:

- *Try this on all the images (e.g. Lena, Landsat, sonar, sar, Box)*
- *Comments?*

1.3 Magnitude Manipulation:

Calculates the FFT of an image, leave the phase unchanged but replaces the magnitude with random values. The inverse Fourier transform is then performed to re-create the image. Examine this on all images and write your observation.

Additional Exercise:

1. ***What would happen if the image is rotated or translated? Try this on different images. (Use imrotate command)***
2. ***Add some additional Noise (randn() function)and see the result in different images.***
3. ***Add blur in the image and evaluate the result.***

4. ***Think about the Low and High pass filter in frequency domain? Is it possible to make if Yes then How? And if not then Why?***
5. ***Do you think it's possible to move an image in Fourier space? Explain?***