Homework Assignment #6

Due Date: Monday, 11 November, 2013 at 11:59pm (MDT)

What to Submit

Please submit **ONE** appropriately-named **pdf file** via Learning Suite containing your solutions to both the WRITTEN and the PROGRAMMING exercises (include the necessary plots and all code that you've written to complete the programming exercises). You may submit separate pdfs for the written and programming portions, but please submit them via Learning Suite.

WRITTEN EXERCISES

1) Compute the Fourier transform of f(x,y) = sin(x) * sin(y). Note that there's a hard way and a couple of easy ways to do this – see if you can find one of the easy ways instead of actually solving integrals.

2) What is the Fourier transform of f(t) = cos(16*pi*t) * cos(64*pi*t)?

PROGRAMMING EXERCISES

For this assignment, you will again need code for the Fourier Transform. As with the last homework, you're welcome to use those provided by Matlab or NumPy (e.g. `fft()`/`ifft()`, `fft2()`/`ifft2()`, `fftshift()`/`ifftshift()`. Again, pay careful attention to the output ranges (e.g. `imshow(IMG, [A B])`).

To help you with the basic structure of filtering programs, here is a matlab script freqFilterScript.m (NumPy should be analogous).

PART A: 1-D Filtering

Design a 1-D low-pass filter to smooth the data in HW6_PA.mat (or HW6_PA.pkl for python). You may use any of the low-pass filters shown in Section 4.8 of the book, or design your own. Make sure to describe your filter and its results/side-effects in your write-up.

PART B: 2-D Filtering / Convolution Theorem

Use the Convolution Theorem to implement a 9x9 box filter (uniform spatial averaging filter) *in the Frequency Domain*. That is, your code should produce the same results as you obtained in Homework #3 for spatial filtering with a uniform-averaging 9x9 kernel, but your implementation should use frequency-domain filtering, **not** convolution. Test your implementation using the image whitebox.png.

PART C: Interference Pattern

The image interfere.png has an interference pattern of unknown spatial frequency, orientation and magnitude (it is, however, a single frequency). Write a program to automatically find and eliminate it. Remember that you'll have to eliminate both that frequency and its inverse frequency.

Hints:

1) The frequency you're looking for isn't necessarily the one with the greatest magnitude, it's the one that is most "out of place".
2) Don't just zero the frequency – having that frequency missing can be just as bad as having too much of it. Try to estimate a reasonable magnitude using similar frequencies.

Programming Exercise Write-up

Please prepare a written write-up (submitted as a PDF) which includes the following:

- All code that you wrote for the exercises (parts A-E).
- The relevant plots and answers to questions from parts A-E.
- A brief explanation of what you did, any challenges you encountered, things that were difficult, unclear, etc.
- How long did the different parts (written, programming) of the assignment take you?