ELEC 539 Digital Image Processing
Assignment 1

Due: Wednesday 17 February 1999

1. Experiment with the matlab commands `image, colormap, gray, fft2, fftshift, conv2, filter2, axis` (start with the `help` command). Construct some binary images of simple shapes (lines, squares, circles, triangles), take their DFTs, and observe the results. Turn in one set of representative plots with interpretive comments.

   Experiment also with the image files in the account *elec539*, directory *images*. These are 256×256, "unsigned character," 8-bit images, so use the colormap `gray(256)` to view them. The command `freadbin` in the elec539 directory can be employed to read these images into matlab.

2. **Loops in Matlab = Bad News.**

   Load the image `lenna.256` into matlab. Call this image $L[m,n]$ Write a double loop (over all rows and columns) to (1) find the $[m,n]$ where $L[m,n] < 100$ and (2) set these pixels to zero. Approximately how long does this take, runtime?

   Now, learn about the `find` command and perform the same operation in *two* matlab statements, with no looping. How long does this equivalent operation take? What does this suggest?

3. **Image Rotation Property of the 2d Fourier Transform.**

   Let $p(x,y) \leftrightarrow P(f_1,f_2)$ be a 2d continuous Fourier transform pair. Show that if $p(x,y)$ is rotated through an angle θ in the the (x,y) plane then $P(f_1,f_2)$ rotates through the same angle.

4. **Median Filter.**

   The median filter is used in a number of signal and image processing applications. When a median filter is applied to an image, a window slides along the image, and the median intensity value of the pixels within the window replaces the intensity of the pixel being processed. Consider a 3×3 median filter, with the center of the window corresponding to the pixel being processed.

(a) Is the median filter linear?

(b) Using an example, show that the median filter tends to preserve sharp discontinuities, such as edges (steps). Constrast this result with a filter based on convolution.

(c) Using an example, illustrate that a median filter is capable of eliminating impulsive (spurious large) values without seriously affecting the values of the pixels around the impulses.

5. **Fourier transform of an image.**

   Plot and describe the magnitude of the 2-d DFT of the lenna.256 image. Make sure you normalize the values for display with the appropriate grayscale color map.

6. **Phase and magnitude reconstruction.**

   Take the 2-d DFT of the lenna.256 image, then invert (using `ifft2`) using only the (a) magnitude and (b) phase. Make sure you normalize the values for display with the appropriate grayscale color map. What do you learn about the relative importance of magnitude and phase?

   Try inverting the DFT using the correct phase and *random* amplitudes uniformly distributed on [0,1] (using `rand`). Comments?

7. With your study group, discuss and synthesize the major *themes* of this week of lectures. Turn in a one page summary of your discussion. You need turn in only one summary, but include the names of all group members. Please do not write up just a "table of contents."