Homework #6
Due Mo. 4/10

You must turn in your code as well as output files. Please generate a report that contains the code and output in a single readable format.

Visit the book website to download companion software, including all the example problems.
`http://www.wiley.com/WileyCDA/WileyTitle/productCd-1118414322.html`

Test Images
Download the sample images from the class website
`http://www.ee.unlv.edu/~b1morris/ee482/docs/hw06`

1. (KLT 11.4)
2. Histogram Equalization
   (a) Perform histogram equalization on the `jetplane.png` image using 256, 128, and 64 bins. Compare the original image and the histogram equalized images by plotting the corresponding histograms and images side-by-side in a 2×2 subplot matrix for each of the bin sizes.
   (b) Perform the equalization in 32×32 blocks. Display the output image. You will find `blockproc.m` useful.
3. Noise Filtering
   (a) Consider image `DSCN0479-001.JPG` as a perfect image. Add white Gaussian noise with variance 0.005. Smooth with a 3×3 and 7×7 box filter and a median filter. Compute the mean squared error (MSE)

$$MSE = \frac{1}{MN} \sum_m \sum_n (I_1(m,n) - I_2(m,n))^2$$

   and the peak signal-to-noise ratio (PSNR)

$$PSNR = 20 \times \log_{10}(255/\sqrt{MSE})$$

   for the noise reduced images. Which filter has the best results based on the error measures? How do the results compare visually?
   (b) Repeat (a) with salt and pepper noise with noise density 0.05.
   (c) Do the filtering again but this time on a real noisy image `DSCN0482-001.JPG` obtained at higher ISO. Compare the results visually only this time. Which filter works best for "real" noise? How much time does each type of filter require (use `tick.m` and `toc.m`)?
4. Spatial Domain Filtering
   The following question operates on the `city.jpg` image.
   (a) Perform image smoothing using a 7×7 averaging filter and a Gaussian filter with $\sigma = 0.5$ and 3. Compare the outputs.

(b) Perform edge enhancement using the Sobel operator (Matlab's default parameters). Repeat using the Laplacian and Laplacian of Guassian operators. Compare the outputs. Be sure to read the help info for `fspecial.m`.

5. Frequency Domain Filtering

   The following question operates on the `city.jpg` image.

   (a) Find the Fourier transform of the image. Be sure to center the frequencies using `fftshift.m`.

   (b) Perform image smoothing in the frequency domain using the filters defined in the previous problem. Compare the output images from the two methods (spatial and frequency).

   (c) Perform edge enhancement using the filters defined in the previous problem.

   (d) Define a lowpass filter in the frequency domain with radius of 1/4 the height. Display the LP filter in the frequency domain and show the result of filtering the input image.

   (e) Repeat with a rectangular filter with the same dimension as the ideal lowpass. Compare the results between the ideal filter and the rectangular approximation.

6. DCT

   The following question operates on the `jetplane.png` image.

   (a) Write a function to compute the DCT coefficients for the image as described in Figure 11.12.

   (b) Give the coefficient output for block 3523 (raster scan ordering). Show the output both as a raw matrix and as the zig-zagged ordered vector.

   (c) Repeat for block 2637. Compare the outputs of the blocks and comment on results.