Homework #4

Due Date: Feb. 13, 2003

1. [10] Lim, Problem 4.6

2. [70] You will examine the ideal circularly symmetric filter and nearly circularly symmetric variants. Create an ideal low-pass filter using the form described in class for $\omega_c = \pi/2$. Hand in all plots and your Matlab code. For all plots (and filters), make the (0,0) location in the approximate center of plot and make sure your axes are accurate.
   a. Create a 64x64 filter, $h(n,m)$.
   b. Calculate the frequency response $H(\omega_X, \omega_Y)$ and display using `imagesc`.
   c. Extract the central 9x9 part to make the truncated filter $h_T(n,m)$.
   d. Describe symmetry properties of this filter, that is, is it circularly symmetric, 4-fold symmetric, 8-fold symmetric?
   e. Calculate the frequency response $H_T(\omega_X, \omega_Y)$ and display using `imagesc`.
   f. Extract a 9x9 filter $h_{T2}(n,m)$, but keep only coefficients for which $n_r = \sqrt{n^2 + m^2} \le 4$.
   g. Calculate the frequency response $H_{T2}(\omega_X, \omega_Y)$ and display using `imagesc`.
   h. Plot the ω_X=0 line for these three filters and compare.
   i. Plot the ω_X=ω_Y line for these three filters and compare.

3. [70] In this problem, we will investigate the creation of an approximately circularly symmetric bandpass filter. Hand in all plots and your Matlab code. For all plots, make the (0,0) location in the approximate center of plot.
   a. Consider a 1D filter with impulse response $h(n) = \left[-\frac{1}{8} \quad 0 \quad \frac{1}{4} \quad 0 \quad -\frac{1}{8}\right]$. Determine and plot its frequency response $H(\omega)$. What kind of filter is this?
   b. Create its circularly symmetric equivalent, $H(\omega)$, where $\omega = \sqrt{\omega_X^2 + \omega_Y^2}$. Plot this using Matlab's `mesh` command.
   c. Determine $h(n,m)$, the 2D impulse response for the circularly symmetric filter.
   d. Extract the central 7x7 part to make the truncated filter $h_T(n,m)$. Print or record these values so that they can be graded.
   e. Determine or calculate the frequency response $H_T(\omega_X, \omega_Y)$ and plot using `mesh`.
   f. Compare H and H_T using `contour`. Use at least 20 contour lines. Do the contours agree? Why or why not?
   g. Plot the central line through both H and H_T. Do these agree?