Homework #8
Due Date: Apr. 10, 2003

1. [10 each] Lim, Problems 10.11, and 10.22.

2. [30] Statistical Image Restoration. Download the template `hw8_2_template.m`. This problem starts with a very similar to problem 4 in HW #6. We will use this model:
    $$g(n,m) = f(n,m) + v(n,m) \quad \text{or} \quad \mathbf{g} = \mathbf{f} + \mathbf{v}$$
    a. Determine formulae for theoretical autocorrelation function for $f(n,m)$ and $v(n,m)$.
    b. Recognizing that for zero-mean real processes the auto-covariance function and auto-correlation functions are the same, determine the covarance matrices for vectorized version of f and v (e.g. $\mathbf{f}$ and $\mathbf{v}$): $\mathbf{K_f}$ and $\mathbf{K_v}$. These need not be circulant.
    c. Solve for $\hat{\mathbf{f}}$ the MMSE estimate of $\mathbf{f}$ from $\mathbf{g}$ using matrix equations and Matlab's `inv` function. Calculate the MSE's and display the results.

3. [50] Vector Quantization (VQ). Download the template `hw8_3_template.m` plus files `kmeans.m` and `dist2.m` for use in this problem. This problem will again use the house image from homework #7. We will implement VQ for 2x2 regions of the image (length 4 vectors).
    a. For an average of 1 bit/pixel quantization, how many reconstruction levels, L, are required.
    b. Choose 1000 training image vectors at random and use them to create an "optimal" set of reconstruction levels.
    c. Quantize the entire image in to a code vector (one number for every 2x2 block of the image). Use the `hist` function to plot the frequency of each reconstruction level.
    d. Reconstruct the image (Matlab code for this is already there) can calculate the average distortion. Display reconstructed image and error image using `imagesc`.
    e. Repeat steps a.-d. for an average of 2 bits/pixel quanitization.

4. [50] PCM with Robert's pseudonoise technique. Using the same image as the VQ problem, we will investigate distortion.
    a. Implement PCM *with* the Robert's pseudonoise technique for 2 bits/pixel on the image of the house. Determine the average distortion.
    b. Implement PCM *without* the Robert's pseudonoise technique for 2 bits/pixel on the image of the house. Determine the average distortion.
    c. Display reconstructed images and error images for each method.
    d. Repeat part a. for 2-7 bits/pixel. Compare to distortion measures to those of VQ.