This assignment will give you an introduction to image processing. Image processing is a form of discrete-time signal processing with two dimensions (x- and y- position) instead of one. Most of your signal processing expertise learned in one dimension applies to two dimensions as well.

Step 1: Load the test images
You are provided three test images. Load them into Matlab using `[img,cm] = imread(filename)` and plot them using `imshow`. Note that images sometimes (not always) come with their own colormaps. After using `imshow` to show the image, try using `colormap` to change the colormap. You can either change the colormap to `cm` (if it was loaded from the image file) or to one of the pre-defined ones provided by Matlab (type `doc colormap` for details).

Step 2: Lowpass filtering the images
Start by making sure you have the Image Processing Toolbox installed. Use the `fspecial` command to build a lowpass filter, `'h'` and then use `imfilter` to apply the filter to your three images. What is the effect of the filter on the images? The `fspecial` command can build many types of filters. I recommend using the `'average'` type but you should feel free to try some of the others. Change the value of `HSIZE` when defining the filter. What effect does `HSIZE` have on the filtered image? Use the `myFFT2` command to examine the frequency content of your filters. Are they all lowpass filters (they should be). What affect does changing `HSIZE` have on the shape of the FFT? How does that fit how `HSIZE` affects the filtered image?

Step 3: Highpass filtering the images
In this step we repeat all the questions from Step 2 but using a highpass filter instead of a lowpass filter. Convert your lowpass filters from Step 2 into highpass using the following procedure. First, create a matrix of zeros of the same size as `HSIZE`. Then set the value in the very center of the matrix to 1 (this effectively creates a two-dimensional impulse). Finally, subtract your Step 2 filter from this impulse. The result will be a high pass filter. Additional question: why does this process result in a highpass filter? (think of what the Fourier Transform of an impulse is).

Honors Students
Use two different methods to try denoising `im_coins_noisy.png`. Start by examining the image and commenting on what kind of noise you see and what you think its frequency properties might be. The first filter you should try is a lowpass filter (see Step 2). Create the best lowpass filter you can to denoise the signal. How does the image look? The second filter method should be a *median* filter which you can apply using the `medfilt2` command. Experiment with different median filter *neighborhood sizes* to see which gives you the best denoising. How does the image look? Which filter type works better in this case? Why? Is the median filter linear or non-linear? Why?

What to hand in: Write a report in IEEE format explaining what you did, what your findings were, and how any of this relates to the standard signal processing intuition we've been studying all semester. Your paper can be as long or as short as you think is appropriate, but don't make it any longer than absolutely necessary.

Work by yourselves or in groups of two. You may consult with other groups for ideas, however, your methods, analysis, and write-up should be uniquely your groups' own. Place your paper (MSWord format only) plus your Matlab code into a single zip file (no need to include the image files). Submit the zip file through Canvas. All assignments must be uploaded by 11pm on Monday April 27th.