Homework 2 (Due: Dec 11, 2015)

1. **Programming.** The need for image padding when filtering in the frequency domain was discussed in our lectures. We showed that images needed to be padded by appending zeros to the ends of rows and columns in the image (see the following image on the left). Do you think it would make a difference if we centered the image and surrounded it by a border of zeros instead (see the image on the right), but without changing the total number of zeros used? Please verify your idea by a Matlab program. You can use your own images for testing.

   ![Image on the left](image1.png) ![Image on the right](image2.png)

2. **Programming.** High-Frequency Emphasis Filtering. In our lectures, we can see that high-pass filters zero out the DC term (the value at the center of a high-pass filter mentioned in our lecture is 0 in the frequency domain), thus reducing the average value of an image to 0. An approach used to compensate for this is to add an offset to a high-pass filter. When an offset is combined with multiplying the filter by a constant greater than 1, the approach is called **high-frequency emphasis filtering** because the constant multiplier highlights the high frequencies. High-frequency emphasis filters have the transfer function

   \[
   H_{HFE}(u, v) = a + bH_{HP}(u, v) \quad (1)
   \]

   where \(a\) is the offset, \(b\) is the multiplier, and \(H_{HP}(u, v)\) is the transfer function of a high-pass filter.

   Use equation (1) to enhance an X-ray chest image, which can be downloaded from the course website. Specifically, use the Butterworth high-pass filter when defining \(H_{HP}\). Set \(D_0\) equal to 5% of the rows of the padded image. Set \(a\) as 0.5 and \(b\) as 2. After the high-frequency emphasis filtering, you can perform a histogram equalization operation to the filtering result to increase the quality of the image further. The test image used in this assignment can be found on our course website.

   The following figure shows the sample result.

   ![Original input image](image3.png) ![Result of enhancement](image4.png)