Intensity Transformations and Spatial Filtering
-Part I-

The term spatial domain refers to the image plane itself, and image processing methods in this category are based on direct manipulation of pixels in an image. This is in contrast to image processing in a transform domain which involves first transforming an image into the transform domain, doing the processing there, and obtaining the inverse transform to bring the results back into the spatial domain. Two principal categories of spatial processing are intensity transformations and spatial filtering. Intensity transformations operate on single pixels of an image for tasks such as contrast manipulation and image thresholding. Spatial filtering performs operations on the neighborhood of every pixel in an image. Examples of spatial filtering include image smoothing and sharpening

What to do for this lab:

1. Histogram Interpretation:
   a. Display the image 'circuit.tif' and its histogram. Note: the option 'axis tight' sets the axis box tightly around the data. You may find this useful when plotting histograms.
   b. In the previous step, the histogram of the image was displayed with the default number of bins. Display the histogram again but this time with number of bins that equals to 64, 32, and 16. What do you notice?
   c. Load the following images: highContrast.tif, lowContrast.tif, bright.tif and dark.tif. Display and interpret their histograms.

2. Histogram Equalization:
   a. Load the demo image 'pout.tif' and perform histogram equalization on it. Display the original and the equalized images, and their corresponding histograms. Interpret your results.

3. Histogram Stretching:
   a. Use the imadjust function to perform histogram stretching on the 'pout.tif' image.
   b. Display the original and the adjusted images, and their corresponding histograms. Interpret your results.
   c. How did the histogram change after the adjustment?

4. Image Brightening using Addition and Multiplication:
   a. Use the imadd function to brighten the image 'moon.tif' (found in the MATLAB library) by adding a constant value of 50 to each of the image pixel values.
   b. Determine the minimum and maximum values of pixel intensities for the original and the modified images. Interpret your results.

c. Use the immultiply to modify the moon image by multiplying the intensities by 1.2. Display the original image, the brightened image by addition and by multiplication in the same figure.
d. For the brightened image by multiplication, explain why the dark regions around the moon (background) do not become brighter as in case of the image brightened by addition.

5. Differences between Images:
   a. Load the following images and display them: 'tools1.tif' and 'tools2.tif'. Subtract the former image from the latter one and display the result.
   b. Calculate the absolute difference (refer to MATLAB documentation) of the above images and display the result. Compare it with the result obtained in part a.
   c. Calculate the difference between the mask image 'maskImage.tif' and the live contrast image 'liveImage.tif' and display both images and the result in one figure. List one medical application of this technique.

6. Darkening Images using Division:
   a. Use image division to darken the image of the moon ('moon.tif') by dividing it by 2.
   b. Calculate the equivalent dark moon image using image multiplication.
   c. Display the original, darkened using division and darkened using multiplication images in one figure and conclude.

7. Image Negative:
   a. Produce the negative of the following image: 'circlesBrightDark.png' (MATLAB library) using three different techniques:
      i. Simple subtraction.
      ii. imcomplement function.
      iii. imadjust function.
   b. For each of the above techniques, display both original and modified images in the same figure. Which method is preferable (if any) and why?