

**Write MATLAB scripts that change the image intensities according to the following:**

1. Image enhancement techniques: build a comparison between using MATLAB functions `imadjust`, `histeq`, and `adapthisteq` on an image. Use `tire.tif` and `pout.tif` images. Your comparison should include histograms of each enhanced image and your own observations.
2. Linear filters (low-pass and high-pass filters):
  - a. Low pass filter, also called a "blurring" or "smoothing" filter, is used to decrease the disparity between pixel values "intensities" by weighted averaging of nearby pixels. On the other hand, the high pass filters, sharpening filter, returns the high frequency components of the image by enhancing the contrast between adjoining areas with little variation in brightness or darkness. On other word, it is designed to increase the brightness of the center pixel relative to neighboring pixels. Consider the following low-pass filters and the high-pass filters and test them with 'cameraman.tif' image and then build a comparison between the results.

i. Low-pass filters

$$filter1 = \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}, \quad filter2 = \frac{1}{10} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 1 \end{bmatrix}, \quad filter3 = \frac{1}{16} \begin{bmatrix} 2 & 1 & 2 \\ 1 & 4 & 1 \\ 2 & 1 & 2 \end{bmatrix}$$

ii. High-pass filters

$$filter1 = \frac{1}{9} \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}, \quad filter2 = \frac{1}{6} \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}, \quad filter3 = \frac{1}{16} \begin{bmatrix} -1 & -2 & -1 \\ -2 & 12 & -2 \\ -1 & -2 & -1 \end{bmatrix}$$

- b. Following the class discussion: Provide an example that demonstrates the following formulas:

$$highpassfilter \text{ image} = original \text{ image} - lowpassfiltered \text{ image}$$

$$lowpassfilter \text{ image} = original \text{ image} - highpassfiltered \text{ image}$$

3. Edge operators (basic gradients and Sobel operators): they are filters used for edge detection algorithms where it creates an image emphasizing edges. The edge map is calculated using the following formula:  $G = \sqrt{G_x^2 + G_y^2}$ , where  $G_x = ED_x * image$ , and  $G_y = ED_y * image$ . Where  $ED_x$  is the edge operator in  $x$  direction and  $ED_y$  is the edge operator in  $y$  direction. Use this definition to find the edge map for the 'cameraman.tif' image and build a comparison between the operators.

$$a. \text{ Basic gradients operator } ED_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}, \text{ and } ED_y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

$$b. \text{ Sobel operator } ED_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, \text{ and } ED_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$