CS 435 – Computational Photography
Assignment 1

In this first assignment we want to get you comfortable with importing and exporting images as well applying basic point-processing algorithms. **Subsequent assignments will likely be far more involved, but we want to you getting your "hands dirty" as soon as possible! 😉**

In this assignment you will demonstrate your ability to:

1. Obtain images and import them into Matlab
2. Demonstrate the application of several point-processing algorithms, including:
    a. RGB→Grey
    b. Binary Images
    c. Contrast Stretching (RGB) & Histograms
3. Render histograms and images.

Grading Scheme:

1. Theory Questions (10pts)
2. RGB → Gray (10pts)
3. RGB→Binary (20pts)
4. Histograms (30pts)
5. Contrast Stretching (30pts)
6. Part 3 Extra Credit (5pts)

Theory Question(s)

1. (2pts) Given a point in 3D space, $(3,5,20)$ and an effective focal length of 10, where will this point appear on the 2D image plane?

2. (2pts) If we have a focal length of 10 and a lens effective diameter of 5, what is the field of view of this camera system (in degrees)?

3. Based on observing a histogram perhaps we decided to create the following pixel intensity mappings in order to stretch the values of a particularly compressed area:

$$[0,20] \rightarrow [0,10]$$

$$(20,25] \rightarrow (10,95]$$

$$(25,100) \rightarrow (95,100]$$

   a. (2pts) Draw a 2D graph showing these mappings. The x-axis will be the input values and the y-axis will be the output values.

   b. (3pts) What are the equations for these mappings?

   c. (1pt) Given a value of 50, what will this value be mapped to?

Programming Introduction:

For this assignment you should first obtain a color image of your choosing (however you like, online, camera, etc.., just keep it PG!). In each section we will apply a point processing technique to your image.

Part 1: RGB→ Gray

The first point-processing thing we want to be able to do is to convert an image from color to grayscale.

Read in your color image and use the following formula to convert it to a grayscale image. You **may not** use a built-in function to do this (i.e rgb2gray).

$$Gray = 0.2989R + 0.5870 * G + 0.1140B$$

Part 2: RGB → Binary

In this part, we want to be able to convert our color image (or grayscale image) into a *binary* image, where each pixel is either black or white.

Produce three binary images, one for each of the following thresholds (as percentages of maximum possible intensity value):

1. $t = 25\%$
2. $t = 50\%$
3. $t = 75\%$

Part 3: Histograms

Histograms are a critical analysis tool use for many computer vision problems. Display four histograms for your image, each of which have 256 bins. **You may not use a built-in function to obtain the histogram**. To plot your histogram, use the `bar` function of Matlab.

1. Grayscale histogram
2. Histogram of the red channel
3. Histogram of the green channel
4. Histogram of the blue channel.

Extra Credit: Use the subplots feature of Matlab to plot the original RGB image along with the three color histograms on one figure.

Part 4: Contrast Stretching

Finally, we want to use the grayscale histogram in the previous part to perform contrast stretching. Based on your histogram, perform contrast stretching. It will be up to you to decide on the region mappings and how many there should be. Again, this should be driven by your histograms in the previous part.

Your submission should include:

- The original grayscale image and its histogram.
- The contrast stretched grayscale image and its histogram.
- **A list of the region mappings along with text justifying your decision.**

Submission

1. Assignments must be submitted via Bd Learn
2. Submit a single compressed file (zip, tar, etc..) containing:
    a. A PDF file containing:
        i. Your answer to the theory question(s).
        ii. The RGB and Gray images for Part 1
        iii. The RGB and Binary images for Part 2 (so 4 images total)
        iv. The histograms for Part 3 (4 total)
        v. The original and contrast stretched image and histograms for Part 4 along with the chosen mapping parameters and their justifications.
    b. A README text file (**not** Word or PDF) that explains
        i. Features of your program
        ii. Name of your entry-point script
        iii. Any instructions on how to run your script
    c. Your source files
    d. The chosen image that you are processing.