HW3 Report

Problem Description

In this homework, we will be implementing histogram equalization, a technique covered previously in class. Histogram equalization is used to improve the contrast and enhance the details in an image by redistributing the intensity values across the entire range of the image. We will also implement linear and quadratic lighting correction as the optional part of the homework.

Proposed Algorithm

The proposed algorithm is based on the following functions I implemented in my solution.py file:

- image _to_matrix: turns the image to a matrix using the PIL library
- Rbg_to_grayscale: converts the image from RGB to grayscale to perform the necessary calculations
- Matrix_to_histogram: create the histogram from the image matrix by filling the pixel value distribution
- Histogram_equalization: this is the main function, which takes in the matrix and histogram, creates the CDF histogram from the initial histogram, then uses this CDF as a look-up table to fill the new matrix, which is then divided by biggest value in the CDF (the last one) and then multiplies by 255, so we have all the values after the lookup be between 0 and 255.

This gives us the final matrix which we use to show the results.
In the solution folder submitted, moon_equalized.bmp shows the output picture from this step, and the equalized CDF and equalized histogram show the fixed histograms after applying the method.

Lighting Correction (Optional)

The section includes 2 parts: the linear and the quadratic methods.

Linear method

In the linear method, we get the X and Y planes, which we then stack them with a bias matrix (all ones) where we take the stack and apply the method discussed in class being the pseudo-inverse method with the unraveled image. We could have also applied the least squares method, but we stick to that one. After applying the method, we get the fitted linear plane, which we subtract from the image. We scale back the image using min-max scaling to get the pixel

values back in their value range. We then return the image. The output of this technique can be seen in the solution folder in the moon_linear_corrected image.

Quadratic method

In this method, the difference with the previous section is that the fitted plane is quadratic. In this method, after getting the X and Y planes, we stack X*X, Y*Y, X*Y, X, Y, and the bias matrix, which we then pass to the pseudo-inverse method with the unraveled image. The rest of the method is similar to the linear one.