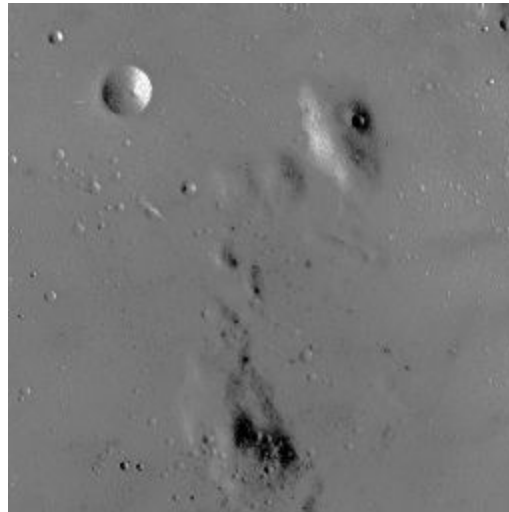**Histogram Techniques and Lighting**

For this project we worked to fix the color distribution of an image with histogram equalization and lighting correction. The image we are trying to enhance is shown below, known as moon.bmp:


Histogram Equalization

The way this algorithm works is to create a histogram based on the color of pixels in the image. With this histogram we can see the distribution of colors in the image. Below is the histogram for moon.bmp:
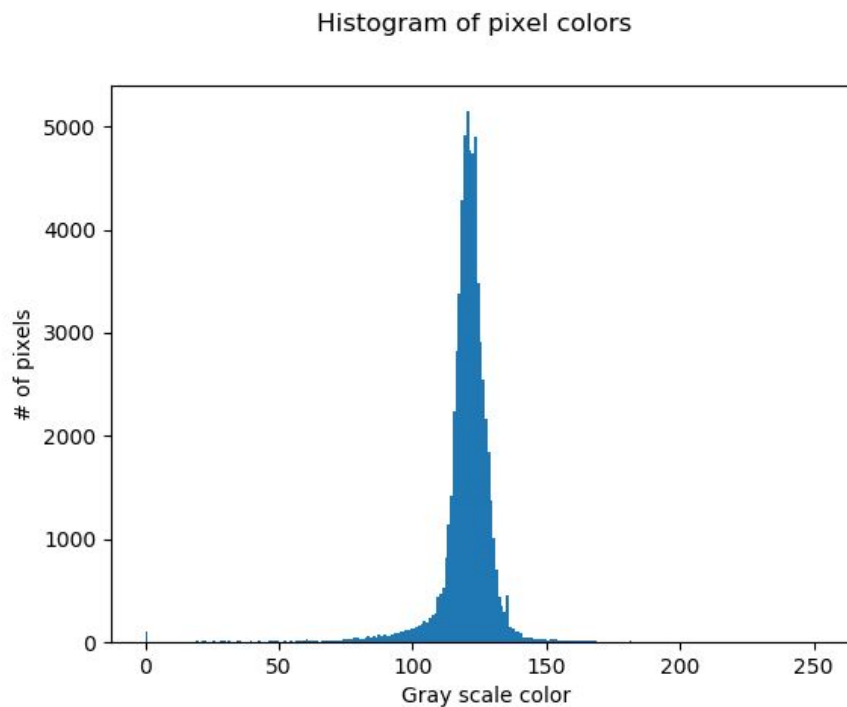
As visible from the histogram we can see that the majority of the color distribution is from the 100 to 150 range. We can then take this data from histogram to create a transformation function to distribute our color equally across the entire color range. This transformation function will be made by accumulating the values found from our histograms and using those to map the composition of our new image. The normalized transformation function for moon.bmp can be seen below:

Transformation Function
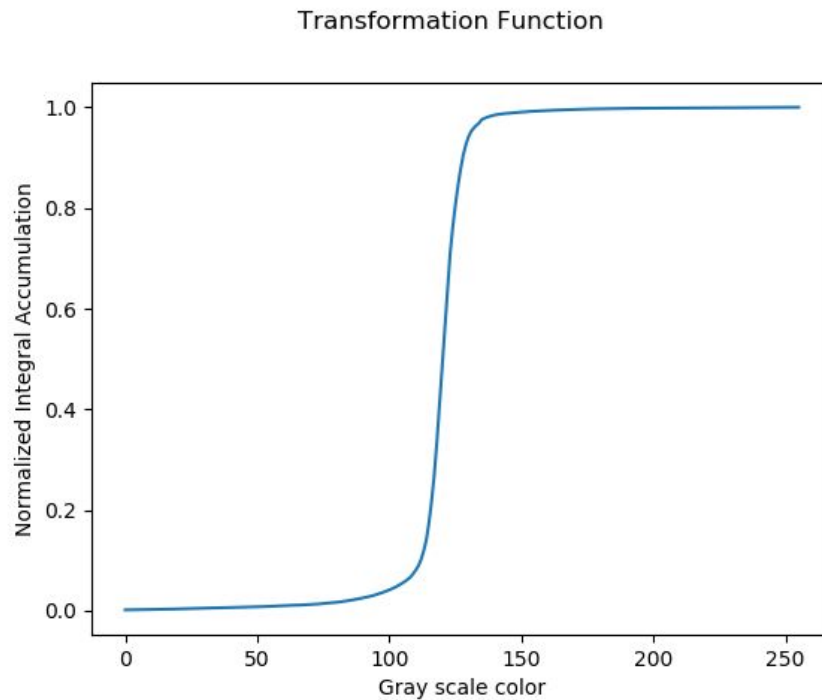
We can intuitively tell that this will work because the higher the distribution of colors in the histogram, the greater the slope in the transformation function so the more spread out that range of colors will be. From our transformation function above we can a large jump in slope in the dense 100-150 color range from our histogram earlier, spreading the color range for the pixels in that color range more evenly. Below is the output of our transformation function to recolor moon.bmp:

We now get a much better color distribution for moon.bmp.

<u>Lighting Correction</u>
Despite our color correction, we can see a dense darker area in the middle of our image that can be fixed with lighting correction. We can do this by doing using the closed form solution of least squares, given as:

$$x = A^T y$$

Where A^T is the pseudo inverse of *A*.

Using this solution to fit a plane and combining it with our original solution allows us to fix the lighting. Here is the combination of a linear plane and the color corrected image of moon.bmp:
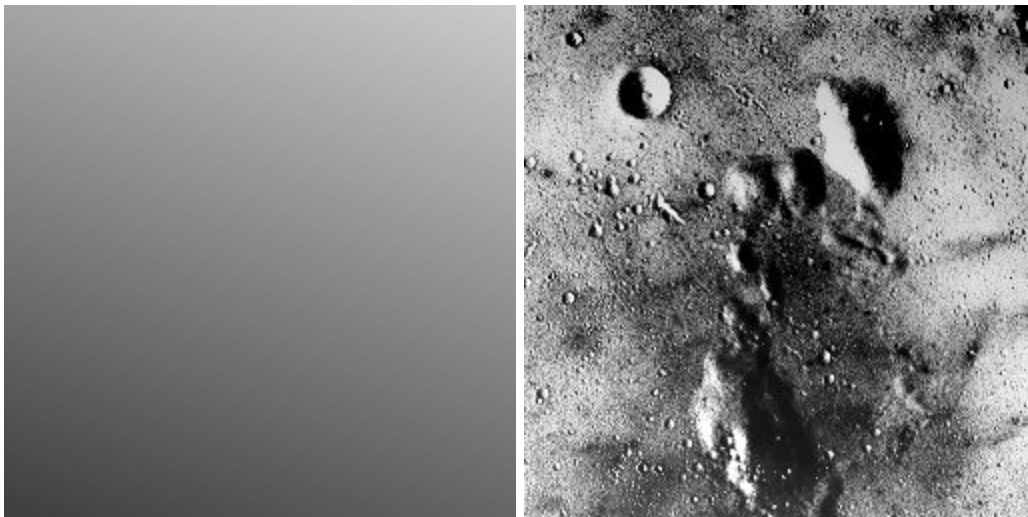
Left is the linear plane used to correct color, and right is the resultant image. Here is the combination of a quadratic plane and the color corrected image of the moon.bmp:
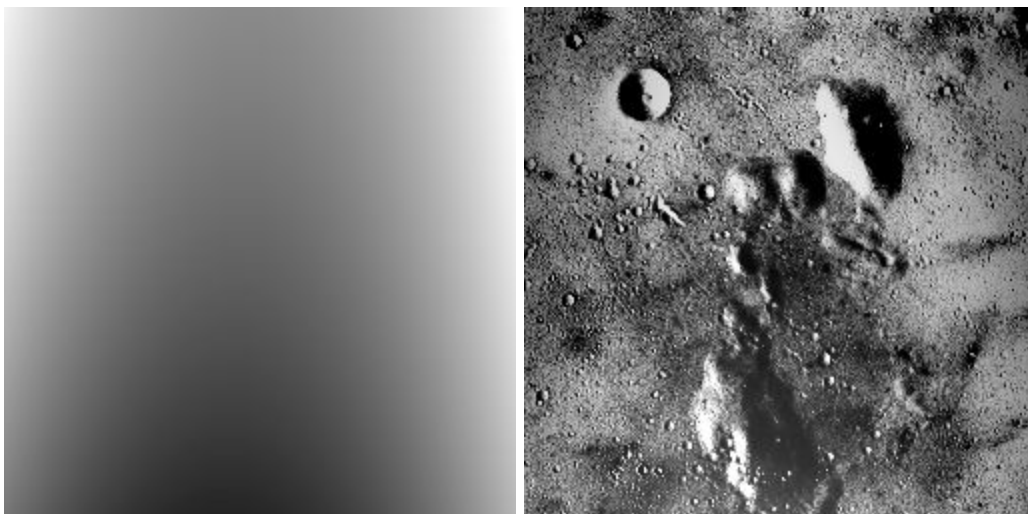
Left is the quadratic plane used to correct color, and right is the resultant image.