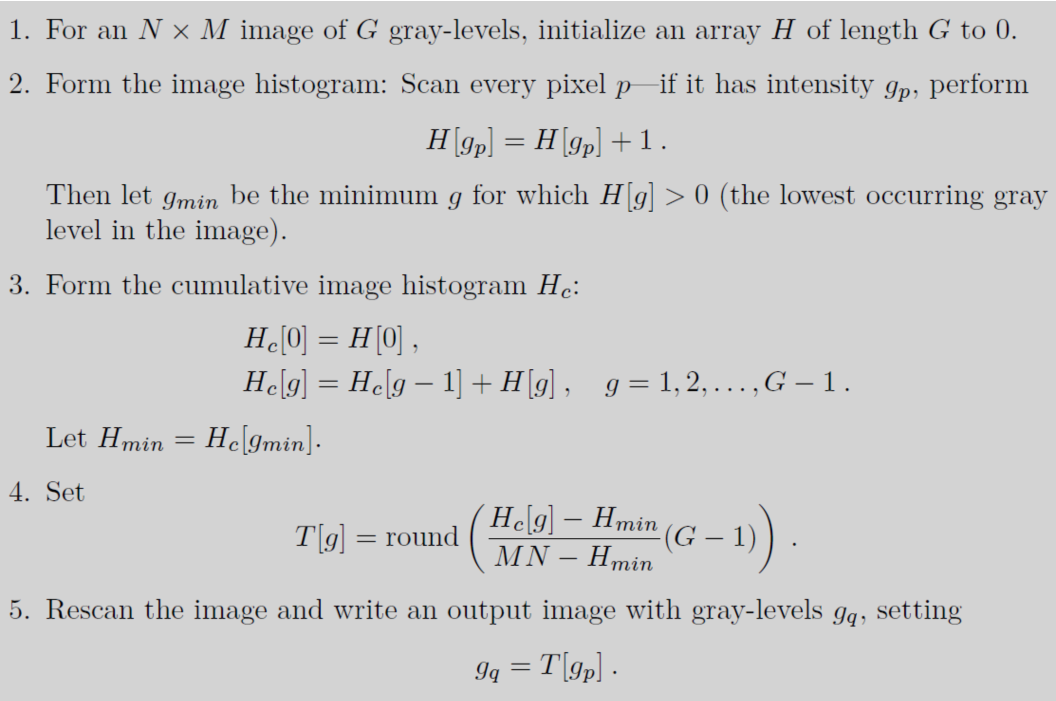
BİL 467/561 – Image Processing

Exercise #1

1. For this question, you will implement the histogram equalization algorithm as detailed in our lecture slides. **You are not allowed to use OpenCV's or any other image/signal processing API's built-in histogram equalization function. (You can use Numpy's histogram calculation function).** Once you implement your own histogram equalization function, you will apply it to the provided test image ("test1.jpg" on Piazza/Resources). You will display your output and make sure that it does not have any visual artifacts. Call the output image you obtain as output_1. You will then apply OpenCV's built-in histogram equalization function to the same test image. Call this second output image output_2.

   Finally, you will take the absolute difference between these two output images (abs(output1 – output_2)) and display it as an image. You will sum all the pixels of this absolute difference image and note total absolute difference. You will see that your output does **not** match OpenCV's results perfectly showing that OpenCV's histogram equalization algorithm is different than the one explained in our lecture slides.

2. For the second part you will implement an alternative histogram equalization method, which is a slight modification of the method we discussed in class. This alternative method is given as:



1. For an $N \times M$ image of G gray-levels, initialize an array H of length G to 0.
2. Form the image histogram: Scan every pixel p—if it has intensity g_p, perform

$$H[g_p] = H[g_p] + 1\,.$$

   Then let g_{min} be the minimum g for which $H[g] > 0$ (the lowest occurring gray level in the image).
3. Form the cumulative image histogram H_c:

$$\begin{aligned} H_c[0] &= H[0]\,, \\ H_c[g] &= H_c[g-1] + H[g]\,, \quad g = 1, 2, \ldots, G-1\,. \end{aligned}$$

   Let $H_{min} = H_c[g_{min}]$.
4. Set

$$T[g] = \mathrm{round}\left(\frac{H_c[g] - H_{min}}{MN - H_{min}}(G-1)\right)\,.$$

5. Rescan the image and write an output image with gray-levels g_q, setting

$$g_q = T[g_p]\,.$$

Once you implement this modified histogram equalization function, you will apply it to the provided test image ("test1.jpg" on Piazza/Resources). You will display your output and make sure that it does not have any visual artifacts. Call the output image you obtain as output_3.

Finally, you will take the absolute difference between these two output images (abs(output3 – output_2)) and display it as an image. You will sum all the pixels of this absolute difference image and note total absolute difference. You should see that the output of this modified histogram equalization method matches OpenCV’s results perfectly.

3. Compare the second algorithm with the first algorithm by carefully inspecting the transform functions they use. What is the main difference between these two histogram equalization algorithms?