Concordia University

Department of Computer Science & Software Engineering
COMP 478/6771 Image Processing

Assignment 1 - Due date: *October 3, 2023*

Part I: Theoretical questions

1. (**6 point**) A greyscale image A has a normalized histogram p_r (modeled by a probability density function) that can be presented by

$$p_r(r) = \begin{cases} -2r + 2, & 0 \le r \le 1 \\ 0, & otherwise \end{cases}$$

Now we want to transform the grey levels of this image so that they will have the normalized histogram p_z, which is given by:

$$p_z(z) = \begin{cases} 2z, & 0 \le z \le 1 \\ 0, & otherwise \end{cases}$$

You can assume continuous quantities. Please find the transform between r and z that will accomplish that.

2. (**20 point**) The purpose of this question is to perform histogram equalization to a given histogram and plot the result. Given the following histogram with their gray levels, and the corresponding number of pixels:

Grey level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
# of pixels	1	9	15	45	93	50	23	12	7	1	0	0	0	0	0	0

   a) (**5 point**) Plot the histogram of the image given in the table above.

   b) (**10 point**) Let r_k be the grey level given in the table, perform histogram equalization by:
   i) Calculate the grey level s_k in the image after histogram equalization from the table.
   ii) Plot the probability density functions $p_r(r_k)$ and $p_s(s_k)$.

   c) (**5 point**) Plot the new histogram after performing the histogram equalization.

3. (**4 point**) Given two images $f(x, y)$ and $g(x, y)$ with their histograms h_f and h_g. Assuming that all the pixels of $g(x, y)$ have the same constant intensity value of c ($c>0$) and both images have positive values. Let u_k be the intensity levels of the pixels formed by an element-wise

arithmetic operation applied to the two images: $f(x,y) - g(x,y)$. Explain the relationship between the histograms of $f(x,y) - g(x,y)$ and $f(x,y)$.

4. (**6 point**) Find all the bit planes of the following 4-bit image:

$$
\begin{array}{cccc}
0 & 1 & 8 & 6 \\
2 & 2 & 1 & 1 \\
1 & 15 & 14 & 12 \\
3 & 6 & 9 & 10
\end{array}
$$

Part II: Programming question

1. Download the two images from the assignment folder and perform the following operations using MATLAB or **any software library** you are familiar with. Please show your steps in the report.

1) (**1 point**) Write a program to read the images.
2) (**3 point**) Write a program to calculate the histograms of the images and display the histograms.
3) (**2 point**) Compare the calculated histograms obtained by using your own program with the ones using the **imhist** function in MATLAB (or an equivalent function in the software library of your choice).
4) (**3 point**) Write a program to do histogram equalization on these images.
5) (**1 point**) Compare the histogram-equalized images obtained by using your own program with the one by using **histeq** function in MATLAB (or an equivalent function in the software library of your choice).