The Hong Kong University of Science and Technology
Department of Computer Science and Engineering
MSBD 5010 (Fall 2024)

Assignment 1

Total = 100 marks
Due: 11:55 pm, October 16, 2024
Assignments must be submitted via CANVAS
Late Policy: Late assignments will incur a 10 scores penalty; only one day late is allowed, i.e., 11:55 pm, October 17

Programming Assignments

In this assignment, you will use Python to complete four functions. They are *gamma_correlation* for grey level power-law (gamma) transformation, *sobeledge* for edge detection, *highboost* for unsharp masking and highboost filtering, and *gaussian_lowpass_filtering* for Gaussian lowpass filtering (GLPF) in the frequency domain.
You need to complete the missing implementations in the corresponding Jupyter Notebook (ipynb) file. You can download the ipynb file (*MSBD5010-24f-lab1.ipynb*) and related files from the course CANVAS website.

Assignment Submission and Marking

1. Your submitted Jupyter Notebook file must be *MSBD5010-24f-lab1.ipynb*.
2. **Runtime requirement**: your program must be able to finish all the above tasks within **5** minutes.
3. You must compress all your files into one file with the following filename format: [your 8-digit student ID]_assign1.rar (or zip), e.g., *09654321_assign1.rar*.
4. If your assignment compressed file has been submitted multiple times before the due date (including late submission date), the new version will replace the old version in marking.
5. Note that we take plagiarism seriously. You are allowed to discuss or share your ideas with your classmates, but you are not allowed to share your assignment's code/pseudocode. Please also follow the referencing skills at https://libguides.ust.hk/referencing/plagiarism to avoid plagiarism.
6. Marks will be deducted if any violations of the above requirements exist.
7. Grading criteria:
   a. The correctness and efficiency of the implemented algorithm.
   b. The clarity and quality of the results.
   c. The program's organization and documentation.
   d. Adherence to the assignment requirements and submission guidelines.

Written assignments

Assignment Submission:

1. You must submit your written assignment in PDF format with the following filename: [your 8-digit student ID]_w-assign1.pdf, e.g., *09654321_w-assign1.pdf*.
2. You must include your pdf file in the rar/zip file mentioned above.

Question W1: Histogram Equalization

Given an image *I* (see below) of size 5-by-5 pixels, with its intensity level ranging from 0 to 7.

Input image				
5	6	7	5	6
7	1	5	6	5
6	0	1	6	5
7	7	5	3	7
3	6	4	3	5

(a) Sketch the histogram of the above image *I*.

(b) Perform histogram equalization, based on the procedure described in the lecture notes, on image *I* and fill in the output image below. Show all steps and round your final answer to the nearest integer. **Remarks**: The intensity range is from 0 to 7.

Histogram Equalized image				

(c) Histogram specification is an automatic equalization technique that adjusts the histogram to match a specified probability distribution. Given the following specified distribution, perform histogram specification on image *I* of (a) and fill in the output image below. Show all steps and round your final answer to the nearest integer.

j	0	1	2	3	4	5	6	7
$P_z(z_j)$	0.05	0.2	0.05	0.15	0.15	0.15	0.15	0.1

Output image				

Question W2: Bilateral Filtering

Consider performing bilateral filtering on the input image. The spatial sigma is 1 and the range sigma is 5, the kernel size is 3. Please show steps and fill in the output image. **Remarks**: Round values to two decimal places.

Input image					
0	0	0	0	0	0
0	1	1	1	1	0
0	1	1	1	1	0
0	1	0	0	1	0
0	0	0	0	0	0

Output image					
*	*	*	*	*	*
*					*
*					*
*					*
*	*	*	*	*	*

Question W3: Image Restoration

Given the following 7x7 grayscale image *I*.

Image *I*						
34	255	60	80	200	255	150
255	120	90	100	75	0	160
45	80	0	130	0	100	255
90	100	110	**0**	0	180	255
0	75	0	90	110	120	170
255	95	90	110	100	0	60
40	80	200	255	120	85	255

(a) Perform median filter of size 3x3 to the center pixel **0** of image *I*.

(b) Perform alpha-trimmed mean filter of size 3x3 with d = 4 to the center pixel **0** of image *I*.

(c) Perform adaptive median filter of initial size 3x3 to the center pixel **0** of Image *I*.