INTRODUCTION TO DIGITAL IMAGE PROCESSING

ASSIGNMENT 3

Due date: Friday, October 31, 2025 by 11:59 pm

Total marks: 5

Late penalty: You are allowed to submit until **Sunday, November 2, 2025 by 11:59 pm** without penalty if you are running late. Submissions made after November 2, 2025, 11:59 pm will not be accepted, and a mark of zero will be assigned to all group members.

All assignments will be done in **groups**, and the same final mark for the assignment will be given to all group members. You are required to stick with the same group as for Assignments 1 and 2.

CONVENTIONS

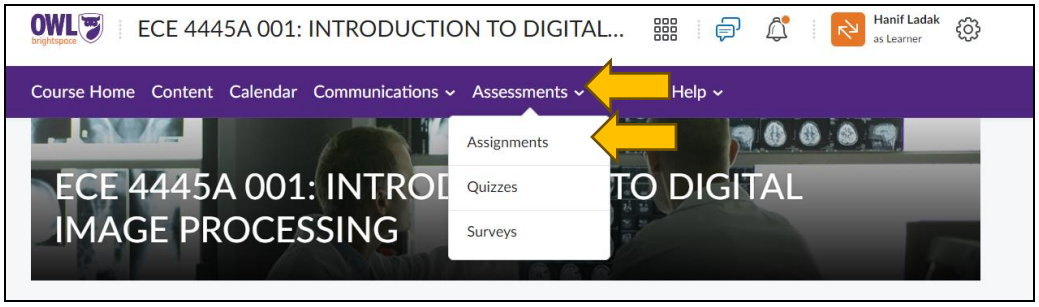
Fixed-point font (`Courier`) is used to denote MATLAB commands, variables, and filenames.

OBJECTIVE

To write your own function for histogram equalization and to understand histogram equalization.

All code and answers requested below must be submitted using OWL. I have included instructions here and will do so for every assignment. To provide answers via OWL:

1. Start a new MS Word file on your computer and enter all your answers into it as directed in the Problems section.
2. Once all problems have been tackled and the requested M-files, TIFF files and MS Word file are ready, one group member should log into OWL and access the course site. Your group should agree on who should submit on behalf of the group to avoid duplication of effort and to avoid overwriting past submissions.
3. Select the "Assessments" pull-down menu and then "Assignments" as shown in the next figure.



4. From the page that comes up, select "Assignment 3". This will likely be prefixed with your group number.
5. If you scroll down on the page that comes up, you will reach the submission section for Assignment 3. Using the button labeled "Add a File", you can upload any requested M-files, TIFF files, and the MS Word document.

Notes:

- These instructions were tested on a Windows desktop computer, and there may be variations if you are using a different device. They were also not tested from the student perspective, but through a simulator.
- You are allowed to submit an unlimited number of times before the deadline.
- We will only receive the last version of the assignment answers that you submit. All previous versions will be overwritten, so it is important for all group members to agree before a submission is made.

PROBLEMS

1. **[2 marks]** Write a MATLAB function that implements the histogram equalization algorithm that was described in the lectures. The function header should have the form:

```
function [im2, f] = myequalize_#(im)
```

where `im` is a `uint8` grayscale image (like `pout.tif` in MATLAB), `im2` is the `uint8` output image, `f` is a vector representing the histogram equalization point operation, and # is your group number. For instance, if you are part of Group_3, your function name would be `myequalize_3`. If you are part of Group_17, your function name would be `myequalize_17`. You can use any built-in MATLAB functions in your code **except for `histeq`**. A mark of zero (0) will be given if you use `histeq`. Note that the output of `histeq` may be different than that of `myequalize_#` since they are using different approaches for histogram equalization, so you cannot use the output of `histeq` to verify if your function is working correctly.

You may use Copilot, but you are responsible for understanding the function as you may be questioned about it on a test or the final exam.

Save the function in a file called `myequalize_#.m` where # is your group number (1, 2, …). **NOTE: Use the exact filename and function name as specified in these instructions. All letters are in lowercase. Your function should be commented.**

Upload this M-file in your submission.

2. Equalize the `uint8` intensity image `pout.tif` using `myequalize_#`. This image is available as part of the MATLAB installation.

   (a) **[0.5 marks]** Using the `subplot` command and the `imshow` command, display the original and equalized images side-by-side in **one** figure window with the original image on the left side of the equalized image. You will need to use the `help` command or Copilot to get more information about `subplot`. Once you generate the display, you should save the figure as TIFF image file with the filename "2a_#" without quotes where # is your group number (1, 2, …). You can use the `print` command along with the "`-dtiff`" option to save the figure as a TIFF file. Again, use `help` or Copilot for guidance.

   Upload the TIFF file in your submission.

   (b) **[0.5 marks]** Using MATLAB, compute and report the minimum and maximum gray levels of the original and equalized versions of the `pout.tif` image. Explain if the differences in minimum and maximum values between the original and equalized images make sense.

   Enter your answer in the MS Word file that you will submit and label this as Problem 2(b).

(c) **[0.5 marks]** Using MATLAB, compute and report the standard deviation of the gray levels of the original and equalized versions of the `pout.tif` image. Explain if the difference in standard deviation between the original and equalized images makes sense.

Enter your answer in the MS Word file that you will submit and label this as Problem 2(c).

(d) **[1 mark]** Plot `f` for input gray levels from 0 to 255. You should have a plot where the horizontal axis is labeled D_A for the input gray level ranging from 0 to 255, and the vertical axis is labeled $D_B = f(D_A)$. Save this plot as a TIFF file with the filename "2d_#" without quotes where # is your group number (1, 2, …). Does the plot of `f` seem correct? Why?

Upload the TIFF file in your submission.

Also, enter your word answers in the MS Word file that you will submit and label this as Problem 2(d).

3. **[0.5 marks]** If the input to a histogram equalization is a constant image in which all gray levels are 128, what is the output image? Explain why the output image is the way it is.

Enter your answer in the MS Word file that you will submit and label this as Problem 3.

As part of this assignment submission, make sure you upload one M-file, two TIFF files, and the MS Word file as requested above.