ECE558 Homework 02 (100 points in total)

Due 10/09/2022

How to submit your solutions: put your report (word or pdf) and results images (.png) in a folder named [your_unityid]_hw02 (e.g., twu19_hw02), and then compress it as a zip file (e.g., twu19_hw02.zip). Submit the zip file through **moodle**.

Problem 1 (10 points): Consider the two image subsets, S_1 and S_2, shown in the following figure. For $V = \{1\}$, determine whether these two subsets are (a) 4-adjacent, (b) 8-adjacent, and (c) m-adjacent. Show the justification in detail.

		S_1				S_2			
0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1	1	0	0	0
0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

Problem 2 (30 points): With ref. to slides 28-33 (not page numbers) in lecture note 08, provide single, composite transformation functions for performing the following operations:

(a) [5 points] scaling and translation
(b) [5 points] scaling, translation and rotations
(c) [10 points] vertical shear, scaling, translation and rotation
(d) [10 points] Does the order of multiplication of the individual matrices to produce a single transformation make a difference? Given an example based on a scaling/translation transformation to support your answer.

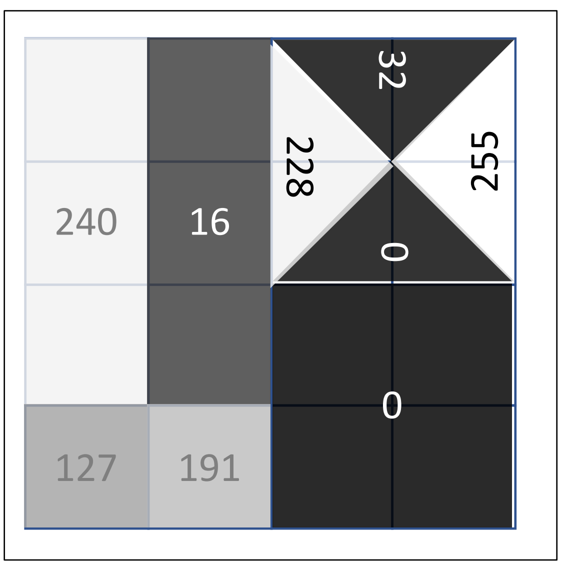
Problem 3 (10 points): An experiment in particle physics is set up with an imaging system whose (processed) output consists of two types of images. Images of type I have at least one particle collision present, while images of type II are "blank" (i.e. they contain no particle collisions). The images are stored sequentially, as they come out of the experiment. The occurrence of collisions is random, and it is known that the bank images occur 80% of the time. In a particular run, the experiment generates 1000 images.

(a) [5 points] what is the probability that if we look at the first three images they will all be of Type I?
(b) [5 points] Will the result be different if we look at the last three images?

Problem 4 (10 points): Give a single intensity transformation function for spreading the intensities of an image so the lowest intensity is 0 and the highest is L-1 (e.g., L=100).

(a) [5 points]: derive the transformation function
(b) [5 points]: check your derived function by writing code and test the code on the provided lena.png image (convert to gray image using built-in functions).

Problem 5 (20 points): Obtain the unnormalized and the normalized histograms of the following 8-bit, $M \times N$ image. Given your histogram either in a table or a graph, labeling clearly the value and the location of each histogram component in terms of M and N.



Problem 6 (20 points): Assume continuous intensity values, and suppose that the intensity values of an image have the PDF (probability density function):

$$p_r(r) = \frac{2r}{(L-1)^2}, \text{ for } 0 \le r \le L-1, \text{ and } p_r(r) = 0 \text{ for other values of } r$$

(a) [10 points] Find the transformation function that will map the input intensity value r into values, s, of a histogram-equalized image.

(b) [5 points] Find the transformation function that (when applied to the histogram-equalized intensity values, s) will produce an image whose intensity PDF is

$p_z(z) = \frac{3z^2}{(L-1)^3}$ for $0 \leq z \leq L-1$, and $p_z(z) = 0$ for other values of z

(c) [5 points] Express the transformation function from (b) directly in terms of r, the intensities of the input image.