Homework 3

Student Name: _____

AuE 8200: Machine Perception and Intelligence
Instructor: Dr. Bing Li, Clemson University, Department of Automotive Engineering

* Refer to Syllabus for homework grading, submission and plagiarism policies;
* Submission files includes (Due Feb. 22, 2022 11:59 pm):
  - This document file (with answers), and with your program results/visualization;
  - A .zip file of source code (and data if any) with names indicating question number;

Note: For questions 1) and 2), you are required to write your own code rather than using any direct build-in implementation from 3rd party (like Matlab, Python, or others) libraries. You may use 3rd party built-in functions to check your results if you would like.

Question 1)

[Sampling/2D-Convolution – 15 pts] Download the image "Lenna.jpg" from the hyperlink. (Lenna or Lena image is a standard test image widely used for image processing since 1973.)

1-1) Convert the image from RGB to gray, using a standard RGB-intensity conversion approach like NTSC, and store the converted image "LennaGray.jpg" as an 8-bit gray image. (2 pts)

1-2) Down-sampling image "LennaGray.jpg" from size 256x256 to 64x64. (3 pts)
Perform the down-sampling and visualize your result.

1-3) Implement the convolution (using basic arithmetic operations only, rather than build-in conv()) of Sobel kernel on the "LennaGray.jpg" for edge detection, visualize and comment your detection result. (10 pts)

Question 2)

[Histogram Equalization – 15 pts.] Take the converted gray image "LennaGray.jpg".

2-1) Perform histogram analysis and visualize histogram distribution (2 pts);

2-2) Calculate and visualize accumulative histogram distribution (3 pts);

2-3) Implement a function to perform histogram equalization for this image, visualize your histogram-equalized image and its histogram distribution. Comments the difference between the two images before/after histogram equalization. (10 pts);

Question 3)

[Line Detection – 30 pts] Download the image "ParkingLot.jpg" from the hyperlink.
Note: For this question, you are free to use any 3rd party libraries.

3-1) Apply and visualize histogram analysis, then find a proper threshold to convert the image to a binary image. (2 pts)

3-2) Apply Hough transformation or other line detection approach to detect multiple lines in the image (You select a threshold for the voting matrix). Visualize the lines in the image space (just as: we saw lines there) and in the transformed space (like in Polar space that we introduced in the class) respectively. (5 pts)

3-3) Comment on: will the two lines as two sides of a particular park space be parallel or not, explain why? (3 pts)

3-4) Design and implement the approaches to find all parking space polygons with the four vertex points for each parking space. Describe your approaches and visualize all detected polygons with different colors overlaid on the original image. The TA will check your code. (20 pts)

Question 4)

Attention: You course Final project topic might be raised from your HW surveys.

[Survey – 40 pts] Write a 2~3 pages survey report on a specific 2D-data measurement/detection problem related to automotive engineering.

- Please targeting at a specific 2D-detection goal/object. e.g.: lane detection, traffic sign detection, pedestrian detection, drivable area detection, a B-scan inspection for a manufacturing component, material characterization using microscopy image, et al. It is not limited to camera data.
- The detection target needs to be specific, rather than generic such as 'Obstacle' since it is not a specific target.

The grading of this question is based on the contents in the aspects of:

- The importance of measuring this target (5);
- The challenges of measuring this target (5);
- Existing approaches of measuring this target (15);
- Existing problems of these existing approaches (10);
- There will be other grading factors (such as novelty, organization, et al) (5);

* Attention: You are encouraged to include any drawing/table in the report;

* This survey is more focusing for the sensing and measurement of a 2D physical quantity or object, rather than comparing multiple 2D sensing modalities.

* You should not literally copy sentences from reference, and use "…" [1] to mark it if you really have to literally cite few sentences. For citations, use brackets （e.g. [1]) in the end of your statements, with reference list in the end of the report.