Homework 2

Student Name: _____

AuE 8930: 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 March. 6, 2020 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 from above 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 and in the transformed space (like Polar space) 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 park space frames with the four vertex points of each frame. Describe your approaches and visualize all detected frames with different colors overlaid on the original image. The TA will check your code. (20 pts)

Question 4)

[Survey – 40 pts] Write a 2~3 pages survey report on a specific 2D-data measurement/detection problem related to automotive engineering (e.g.: lane detection, traffic sign 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. A negative example: 'Obstacle detection in 2D image' is not considered to be a specific problem because obstacle is not a specific target).

The grading of this question is based on the contents which the survey covers:

- The importance of this measurement (5);
- The challenges of measuring this target (5);
- Existing solutions of measuring this target (15);
- Existing problems of measuring this target (5);

There will be other grading factors (such as novelty, organization, et al) (10);

* You are encouraged to include any drawing/table in the report;
* Attention: use "…" [1] to cite any sentence you literally copied and use … [1] to cite a content you referred to, with reference list in the end;