Homework 1

Student Name:	
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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 to Canvas (Due: Tues. Feb. 4, 2020 11:59 pm), including:
 - This document (with answers), and with your program results/visualization;
 - A .zip file of source code (and data if any) with names indicating question number;
- 1. Visualize continuous period signal $x(t) = 2 + 3 * \cos(500 \pi t) + 2 * \cos(1000 \pi t) + 3 * \sin(2000 \pi t)$ in time-domain (axis: Amplitude and t) and visualize its digital Fast Fourier transform (axis: Amplitude and f). Given Sampling frequency as 1K HZ. (5 points)
- 2. Visualize discrete signal x(k) = 0 for k ∈ [0 499] and = 1 for k ∈ [500 1000) µs (sampling frequency as 1M HZ) in time-domain (Amplitude over t) and visualize its digital Fast Fourier transform (Amplitude over f), find its -3dB (called half-power) bandwidth frequencies (f_low, f_high) in frequency spectrum. (10 points)
- 3. For discrete signal x(k) = 20 for $k \in [0.499]$, add a normally distributed random noise n(k) (mean 0, variance 1) to the signal, and get x'(k) = x(k) + n(k). Then, apply a normalized (mean 0, standard deviation 1) <u>Gaussian kernel</u> (windows size 3 and 11 respectively as a low pass filter, then rescale all elements to make sure the sum is 1) to perform convolution y(k) = x'(k) * h by using basic arithmetic operations only.
 - a) Visualize both x(k) and x'(k) in one figure (10 points)
 - b) Visualize both x(k), and y(k) based on kernel window size 3 in one figure (10 points)
 - c) Visualize both x(k), and y(k) based on kernel window size 11 in one figure (5 points) Tip: You may consider using zero-padded for edges during convolution operation
- 4. Find an online open dataset (such as but not limited to <u>KITTI</u>, <u>NUSCENES</u>) containing Radar data and its labelling, and pick up partial data of a Radar.
 - a) Visualize a continuous time frames (like a few seconds) for the data of a Radar in 2D drawing visualization; (5 points)
 - b) Visualize objects by its labelled data on the above visualization; (15 points)
- 5. 2~3 pages of survey on a particular 1D physical signal related to vehicles (40 points), (such as: 1D Radar, vibration/friction/temperature/speed/... signals). The grading of this question is based on the contents which the survey covers:
 - The importance of this signal measurement (5 points);
 - The challenges of measuring this physical signal data (5);
 - Existing solutions of measuring this physical signal (15);
 - Existing problems of measuring this physical signal (5);
 - Others not limited to above (such as novelty, organization, et al) (10)
 - * You are encouraged to include any drawing/table in the report;
 - * Attention: Survey a particular 1D signal, not survey/compare multiple 1D signals.
 - * 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;