ME5413: Autonomous Mobile Robot

Homework 1: Perception

AY2022/23-Sem 2

Due date: 12 February 2023

Important note: All homework is meant to be done in Python/MATLAB with only CPU computation. No GPU usage is allowed. Late submission will not be allowed.

Introduction: The aim of this assignment is to get students to familiarise themselves with perception algorithms.

Task 1: Lidar Clustering

In **task1_lidar_clustering** folder, there are 10 lidar samples and a Jupyter Notebook (task1_lidar_cls.ipynb) with a template of the code.

A) Lidar Clustering aims to provide bounding box representations of the lidar point cloud data. There are various methods available, and the lecture covers one – **DBSCAN**. In this task you are expect to perform lidar clustering of a set of 10 lidar scene samples. Perform lidar clustering of the point cloud using DBSCAN of all objects in the scene.
B) Perform lidar clustering of the point cloud using any other method/library provided. *(Reference: https://scikit-learn.org/stable/modules/clustering.html)*

In the report do specify the parameters used for each method in a) & b). Do describe the motivation for the method selected for Task 1b as well. Save your results as a *json* file.

Task 2: Image Segmentation

Requirements: MATLAB - Computer Vision Toolbox, Deep Learning Toolbox, Deep Learning Toolbox Model for ResNet-18 Network

Under **task2_segmentation** folder, there are 10 samples.

A) Perform Image segmentation using the method: **DeepLabv3** with the MATLAB toolbox, on the 10 sample images provided.
Link for the model = 'https://ssd.mathworks.com/supportfiles/vision/data/deeplabv3plusResnet18CamVid.zip';
Modify the network's output classes to these output classes:
1. vehicles
2. bicycles and motorcycles
3. pedestrians
4. others
5. drivable surface

B) The performance of the segmentation network is not 100% accurate in part 2A. Are there any other points of failure in the network? Take up to 5 images of your own to show these points of failure. Illustrate your claims with images and segmentation results on these images.

You may use **DeepLabv3** or any other MATLAB toolbox on up to 5 images taken by your project group. You will be evaluated on uniqueness of failure points with justification.

C) Suggest improvements to the method, without any MATLAB toolbox functions, implement it and show results.

For part 2A-2C, save your segmentation results as images – you may provide legends or annotations to support your results.

Bonus Task: Implementation in ROS

In **task3_bonus_task** folder, there is a rosbag.

1. Perform Lidar Clustering in ROS by subscribing to the topic - /me5413/lidar_top
2. Save your clustering results as a rosbag.

Submitting your completed Homework Assignment:

Generate a non-password-protected zipfile of this folder and upload it to CANVAS – under Assignment 1. We will use the latest version, regardless of who uploads. Name of Zipfile: "YourHomeWorkGroupNumber_Homework1.zip" (e.g. 43_Homework1.zip - for group 43)

1. Report details:
    a. Homework Group number
    b. Matric numbers of group members (e.g. number starting with A0..)
    c. Maximum number of **5 pages for the report.**
2. Provide a README to run your work.
3. All code and results are to be stored in the following three folders
    a. Task1:
        i. Code: MATLAB/Python Jupter Notebook
        ii. Results: lidar_clustering.json (suggested to save your results as a json file)
    b. Task2:
        i. Code: MATLAB files
        ii. Results: Image files
    c. Bonus_Task:
        i. BonusTask_rosbag.bag
4. Evaluation of tasks will be based on
    a. Performance/Accuracy
    b. Technical explanations
    c. Code executability