CPE 470/670 Fall 2023
Project Deliverable 2

Instructor: Parikshit Maini Submission Deadline: 11:59 pm Tuesday, November 21, 2023

All text answers must be written in a text document. Paper submissions or scanned submissions will not be accepted. You can use word, notepad or latex to write these. All code must be written in Python. Zip together all submission material and submit the Zip folder. All questions are compulsory.

This is a project deliverable and must be completed and submitted as a team. You are not permitted to seek help from people outside the course or AI based tools. You are permitted to refer to class notes, lecture materials, books and other online teaching resources. You are not permitted to use existing implementations or library functions except for standard basic functionality unless explicitly approved by the teaching staff. In case of doubt check with the Instructor or TAs. Use of standard Python libraries for basic functionality is acceptable. Cameras for the project will be distributed in class on November 14, 2023.

Question 1a (10 points) Mount the LiDAR sensor on the Pioneer Robot and connect to RPi. Identify the geometric center of your robot and measure the mounting location from the center of the robot so you know its relative pose from robot center. Write ROS code in Python to interpret the LiDAR data packet and retrieve the point cloud in polar coordinates.
Question 1b (15 points) The environment for the deliverable is set up in rooms 342 in SEM building in a similar configuration as shown below. The origin of the frame of reference along with two axes is marked on the floor. Place the robot at the marked location, collect LiDAR data of the environment and use the data to detect the opening in the environment. You can use the code that you have developed for HW2 solutions. You need to detect and print the (x,y) coordinates of both points of the opening. At the time of evaluation, the environment, including opening, origin location and orientation will be modified to verify your code. The reference frame is fixed to be orthogonal.

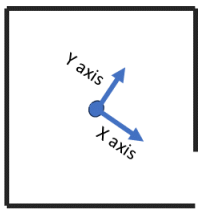

Figure 1: An instance of the operating environment for deliverable 2

Question 2a(5 points) : Mount a camera on the Pioneer in front facing configuration. Identify the geometric center of your robot and measure the mounting location from the center of the robot so you know the relative pose from robot center. Place the Pioneer on the point marked as origin on the floor. Write Python code using ROS to capture and extract image frames from the camera. Use the controller to turn the robot to capture image frames at 0, 90, 180 and 270 degree angular orientations of the pioneer so as to cover all directions. Plot the image frames.
Question 2b(10 points) : Write Python code to perform camera calibration to accurately estimate the intrinsic parameters of your camera. A Chessboard and a Charuco board pattern are provided in room 342 in SEM (you can use either). This is a shared resource, please do not remove it from the room. Save the camera calibration matrix. You are permitted to use any library calls for camera calibration.
Question 2c(15 points) : There is an ArUco code marker placed in the environment from the DICT_4X4_50 dictionary pattern. Write a Python program to detect the ArUco marker ID and plot a bounding box around the marker in the image frame captured. Estimate the pose of the ArUco marker in the origin's frame of reference. You are permitted to use any library calls. For evaluation, a different ArUco marker will be used and will be placed at a random location in the environment.