Robotics, Lab assignment 1

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Due on: 08-12-2024, 23:59:59

Introduction

The objective of the lab is (i) to understand the estimation of orientation from data obtained with a rate-gyro sensor, and (ii) exemplify the use of an industrial-grade serial manipulator.

This lab assignment is composed of 10 tasks that must be addressed individually. These tasks work on datafiles, individually supplied to each group, containing measurements obtained from an accelerometer and a rate-gyro while moving along some trajectory. No two datafiles are identical.

Each datafile contains the measurements obtained with the sensor along, approximately, 20 seconds. During the initial 5 seconds (approximately) the sensor has no movement whatsoever, i.e., it is in a static configuration.

The first 6 tasks involve, only, the processing of the datafile assigned to each group and some theory work. The max grade for these first 6 tasks is 16/20. To reach maximum grade, 20/20, the remaining 2 tasks must also be completed.

The datafiles are text based (readable), and the format, per line, is:

“time” “a_data_1” “a_data_2” “a_data_3” “w_data_1” “w_data_2” “w_data_3”

where “time” is the time, in microseconds, at which the sensor data was obtained, the “a_data_i” numbers correspond to the accelerometer and the “w_data_i” numbers correspond to the rate-gyro.

Either Matlab or Python can be used to solve the computational tasks.

Note that current versions of Matlab 2024 already have specific functions that accept data from accelerometer and rate-gyros and estimate the corresponding trajectories. Similarly, there are Python libraries online with identical capabilities. These are not to be used to solve any of the tasks below, though it is acceptable/desirable they can be used for comparison purposes.

Tasks

Task 1 - Plot together (i.e., in the same plot) the components along each axis of the sensor. Identify which component belong to which axis.

Task 2 – Remove outliers and denoise each component using a suitable filter, e.g., a median filter. Plot the filtered components together in another plot.

Task 3 – Write down the equations to reconstruct the trajectory of the sensor in the cartesian (x,y,z) space from the accelerometer data.

Task 4 - Write down the equations to reconstruct the trajectory of the sensor in the orientation (Euler angles alpha, beta, gamma) space from the rate-gyro data.

Task 5 - Plot the trajectory in the orientation space reconstructed from the dataset. Comment the results obtained.

Task 6 - Plot the trajectory in the 3D cartesian space reconstructed from the dataset. Comment the results obtained.

The remaining tasks make use one of the Scorbot VII manipulators in the lab.

Task 7 – Write down the equations for the direct kinematics of the Scorbot VII in the lab. The necessary data should be available from the Scorbot VII manual (available at the course webpage) and/or by direct measurement on the robot.

Task 8 – Can a Scorbot VII execute the orientation trajectory reconstructed in Task 5 ?

Deliverables

- Report detailing the techniques used and results obtained.
- All the software produced, including comprehensible instructions to allow anyone to install and run it.

Suggested schedule

Task 1 – 17 November 2024

Task 2 – 20 November 2024

Tasks 3 and 4 – 22 November 2024

Tasks 5 and 6 – 29 November 2024

Tasks 7 and 8 – 8 December 2024.