THE DEPARTMENT OF AUTOMOTIVE ENGINEERING

CLEMSON UNIVERSITY

AuE 8220: Autonomy: Mobility and Manipulation, Fall 2022

Homework #3: Interpolation, Inverse Kinematics

Assigned on: September 27^{th} 2022 Due: October 4^{th} 2022, 1:00 PM

Instructions: Attempt all homework problems and software project together with your team-member for the rest of the course.

For Problem 1 and 2 refer Chapter 3 in Peter Corke's Textbook

Problem 1 (Also in earlier homework)

The relative orientation of two frames of reference is given as follows. Frame A forms the base/reference frame while Frame B is obtained by taking Frame A and rotating it by the following three incremental relative rotations ZYZ: R[z,pi/4] followed by R[y,pi/6] and finally R[z,pi/9].

Assume that we interpolate from Frame A (t=0) to Frame B (t=10) smoothly using:

A) Interpolation of the elements of the relative-orientation matrix (from Frame A initially coincident with the inertial frame to Frame B
B) Interpolation of absolute XYZ Euler Angles representation
C) Interpolation of the elements of the relative-orientation matrix (from Frame A initially coincident with the inertial frame to Frame B using **Peter Corke's Robotics Toolbox** and compare results obtained from part A
D) Interpolation of absolute XYZ Euler Angles representation using **Peter Corke's Robotics Toolbox** and compare results obtained from part B

For each of the above cases plot the orientation of the intermediate frames at t= [0:2:10] secs (if possible on the same graph; if not in 4 subplots). You can use Matlab coding for Part A and Part B calculations. Bonus points: Include an animation of the interpolation as an MP4 as well as your code files (which should be setup to run automatically). Use a GUI!!

Problem 2

Given that the manipulator structural parameters are a_1= 2, a_2= 1 and that this manipulator is required to move between position $P_1 = (x_1, y_1,) = (-1, 1)$ and $P_2 = (x_2, y_2,) = (2, 1)$ in 10 seconds. However, its motion between these initial and final positions can be achieved in a variety of ways and you will explore some of these during this homework problem. In particular, you will try the following schemes:

A) Assuming that the manipulator starts and stops from rest – fit a cubic polynomial between the start and finish positions in each of the Cartesian coordinates.
B) Assuming that the manipulator starts and stops from rest – fit a quintic polynomial between the start and finish configurations in terms of the joint coordinates.
C) Assuming that the manipulator starts and stops from rest – fit a cubic polynomial between the start and finish positions in each of the Cartesian coordinates using **Peter Corke's Robotics Toolbox** and compare the results from part A
D) Assuming that the manipulator starts and stops from rest – fit a quintic polynomial between the start and finish positions in each of the joint coordinates using **Peter Corke's Robotics Toolbox** and compare the results from part B

In separate graphs, plot (i) X vs t for all interpolation schemes; (ii) Y vs t for all interpolation schemes; and (iii) Y vs X for all interpolation schemes. Similarly in separate graphs plot the various interpolated joint trajectories (iv) θ_1 vs t for all interpolation schemes; (v) θ_2 vs t for all interpolation schemes; Submit a total of 5 graphs. For plotting some of the results, make sure that you choose an adequate resolution for the problem.

You can use Matlab coding for Part A and Part B calculations. Bonus points: Include an animation of the interpolation as an MP4 as well as your code files (which should be setup to run automatically). Use a GUI!!