Assignment 5

ME 639 - Introduction to Robotics

IIT Gandhinagar

Assigned: 29 October, 2023
Due: 11:59pm on **Tuesday, 7th November, 2023** on GitHub
Collaboration Policy: Discussion with all classmates (including phone calls and WhatsApp messages) and TA are permitted. Any exchange of (or showing) equations, or lines or sections of code are permitted only within your groups.

Tasks:

1. Write a subroutine to solve for the inverse position kinematics for the Stanford manipulator using the discussion in Section 4.3.2 in the textbook. Plug in a few representative numerical values to compute the joint variables. Then confirm if you plug in these resulting joint variable answers with your earlier forward position kinematics code that you are indeed obtaining correct answers.
2. Write a python subroutine to calculate the joint velocities using end-effector cartesian velocities (using the discussion in Section 5.4 in the textbook). Heads up: You don't need to write the part about calculating joint accelerations.
3. Read about Euler angles from Section 2.3.2.
4. Read about spherical wrist and tool frame from Section 1.4.7, the last few paragraphs before the Summary 3.2.1, step 6 of Summary 3.2.1, and about its inverse kinematics from Section 4.4.
5. Write a python subroutine for the inverse kinematics of the spherical wrist using the discussion in Section 4.4.
6. Consider a 3-DOF robot of your choice (you might also consider just the first three degrees of freedom of UR5 robot used in exam 1). Complete the following tasks with this robot of your choice:
    a. Write a code incorporating dynamics of the 3 DOF robot. Further, simulate it with small initial conditions and small constant torque values to observe the dynamic behavior (important to keep the torques small, else the robot may be continuously accelerating).
    b. Code all four versions of Independent joint control (simple, slightly more sophisticated, feedforward, computed torque), and implement all four versions on the dynamics code above. Pick a relatively simple desired trajectory and some small stochastic disturbance (to be added to the code), and test and compare the performance of all four independent joint control methods. Document the results in terms of plots and comparisons.