Mini-project

ME 639 - Introduction to Robotics

IIT Gandhinagar

Assigned: 3 August, 2021
Due: 11:59pm on Friday, **13th August, 2021**
on GitHub repository https://github.com/harishpmiitgn/iitgn-robotics/
Collaboration Policy: Collaboration is not permitted on this assignment. All submitted material must be your own material.

Consider the 2R elbow manipulator discussed in class with two links of masses m_1 & m_2, lengths l_1 & l_2, and moments of inertia I_1 and I_2, respectively.

Tasks:

0. Include a neat handwritten derivation of the 6 key equations derived in class with regard to the kinematics, dynamics, and statics of the elbow manipulator. Include neat free-body diagrams, assumptions, and any explanations to go with the derivations.
1. Write a Python simulation with visualization that implements a trajectory following controller that makes the robot follow an arbitrary end-tip trajectory.
    a. Also, analyze how different the results are when dynamics are included versus not included (try both low-speed and high-speed trajectories).
2. Assume a wall location and orientation, develop and implement using a Python simulation and visualization the task of the robot reaching the wall and then applying a prespecified force in the normal direction of the wall.
3. Develop and implement a control scheme that makes the robot end-tip act like a virtual spring centred at the mean position of x_o and y_o. Demonstrate the performance of this method by initializing from a few different points away from x_o and y_o.
4. If both joint angles can only sweep between 35 degrees and 145 degrees, determine and plot the workspace for the robot.

Hint: Please note that each of the above tasks may involve many sub tasks. For instance, for each of the tasks, first, a robot dynamics model has to be coded up to simulate the behaviour of the robot and observe the effects of any control or environmental action taken. Likewise, a separate visualization subroutine can be written that can serve to support all the codes and tasks. Further, for task one, you might also have to verify first if the trajectory chosen is in the workspace (and hence feasible). There may be a few more checks like these. These are fairly complex coding tasks so please start well ahead of the deadline.