Assignment 2

ME 639 - Introduction to Robotics

IIT Gandhinagar

Assigned: 23 August, 2022
Due: 11:59pm on Friday, **2nd September, 2022**
on MS Teams
Collaboration Policy: Collaboration is not permitted on this assignment. All submitted material must be your own material.

Tasks:

1. Show that $RS(a)R^{T} = S(Ra)$, where $R$is a rotation matrix.
2. Work out the various coordinate frames (show them on a clearly marked figure) and work out p_0 using a composition of homogeneous transformations for the RRP SCARA configuration.
3. Write a python code incorporating the above calculation that can return the position vector of the end effector for any given configuration of joint variables (angles and extension).
4. Repeat the above exercise for the Stanford-type RRP configuration, again write a python code that can return the position vector of the end effector for any given configuration of joint variables (angles and extension).
5. A drone took off from a base station and traveled 10m straight up. If you consider an inertial frame attached at the base station with the z axis pointing straight up and x and y axes along the ground forming a right-hand system, then this would be 10m in the z direction. At this hover point, the drone orientation is as if it completed a 30-degree rotation about the x-axis followed by a 60-degree rotation about the resulting new (current) z-axis. Further, it is then observed using a lidar installed on the drone that an obstacle is 3m exactly above the drone (in the drone frame). Find the position vector of the obstacle with respect to the base coordinate frame using a composition of homogeneous transformations. Also, show the choice of coordinate frames using a neat sketch.
6. Read about a few different types of gearboxes typically used with motors in a robotic application and explain in 2-3 sentences in your own words some key pros and cons of each gearbox type and where it is typically used. Further, explain if you would typically see a gearbox used along with a motor in a drone application. Explain the reasons.
7. Derive the Manipulator Jacobian for the RRP SCARA configuration.
8. Write a python code implementing the above Jacobian such that the entire Jacobian matrix is output for any given values of joint variables.

9. Derive the Manipulator Jacobian for the RRR configuration with all rotation axis parallel to each other (entire robot is planar like the elbow manipulator).
10. Write a python code implementing the above Jacobian such that the entire Jacobian matrix is output for any given values of joint variables.

Submit the assignment in the form of a PDF along with four separate python codes for tasks 3, 4, 8 and 10.