Assignment 3

ME 639 - Introduction to Robotics

IIT Gandhinagar

Assigned: 28 August, 2024
Due: 10:59am on Saturday, **31st August, 2024**
Submission on GitHub.
Collaboration Policy: Collaboration is permitted on this assignment. However, all submitted material must be your own material.

Tasks:

1. Derive the Manipulator Jacobian for the RRP SCARA configuration.
2. Write a python code implementing the above Jacobian such that the entire Jacobian matrix is output for any given values of joint variables.
3. Derive the Manipulator Jacobian for the RRR configuration with all rotation axis parallel to each other (entire robot is planar like the elbow manipulator).
4. Write a python code implementing the above Jacobian such that the entire Jacobian matrix is output for any given values of joint variables.
5. Review the discussion on singularities, decoupling of singularities, and various examples of singularities and singular configurations in the textbook. Describe in 3-4 sentences in your own words what is a singular configuration and how do you find singular configurations. Also, can you detect if a particular configuration is close to a singular configuration using the Manipulator Jacobian?

The following tasks are to be completed based on reading of Chapter 3 in the textbook. I also strongly recommend reviewing the following video before (and after) reading the textbook.

6. Read the definition of DH parameters in the textbook including the summary of steps. Pay particular attention to the end-effector frame and wrist as that was not discussed in class.
7. Write a python subroutine that takes in as inputs the number of links and the DH parameters in table/matrix form, and returns the (a) complete manipulator Jacobian, (b) the end-effector position, and (c) end-effector velocity. If you need any other inputs (such as information about the nature of joints (R/P), incorporate this as an additional input to the python code. However, the code is to be setup in a way that if this information is not provided, default assumption of all joints being revolute joints is to be assumed.

8. Apply the above code to the two common RRP configurations of Stanford manipulator and SCARA manipulator. Verify that the results obtained using the code match with the expressions derived earlier (by yourself and in the textbook). You may choose a few configurations (numerical values) to verify your results.
9. Solve problem 3-7 in the textbook and also verify your hand-derived answers using the code in Task 3.
10. Solve problem 3-8 in the textbook and also verify your hand-derived answers using the code in Task 3.

Submit the assignment in the form of a PDF along with the separate python codes for the appropriate tasks