UNSW SYDNEY

MTRN4230 Lab 03

1. Aim

Lab 3 aims to familiarise you with the scripting interface and Peter Corke's robotic toolbox (i.e., RVC toolbox) using MATLAB, which provides a more powerful and convenient way to control the UR5e. We will go through examples on using the RTDE Library to establish a TCP/IP connection with the UR5e, send commands, and receive motion data. As there are a lot of new toolboxes that are introduced this week, so ensure you take your time and go through all the examples provided to familiarise yourself with them.

2. Pre-lab

You must have completed the ROBOT-1 assessment and installed Peter Corkes RVC Toolbox in MATLAB.

- ## 3. Lab Activities

During the lab you should complete try to complete the tasks below. You may test your program on the UR5e in the Lab today. The demonstrator will assign you into groups of 6 and assign you to one UR5e. You will be sharing that UR5e amongst the other students within the group for the duration of the trimester.

<u>3.1 RVC ToolBox</u>

- Follow along with your lab demonstrator's presentation of the example code provided:
  - RVC: Geometry_2D
  - RVC: Geometry_3D

<u>3.2. Scripting</u>

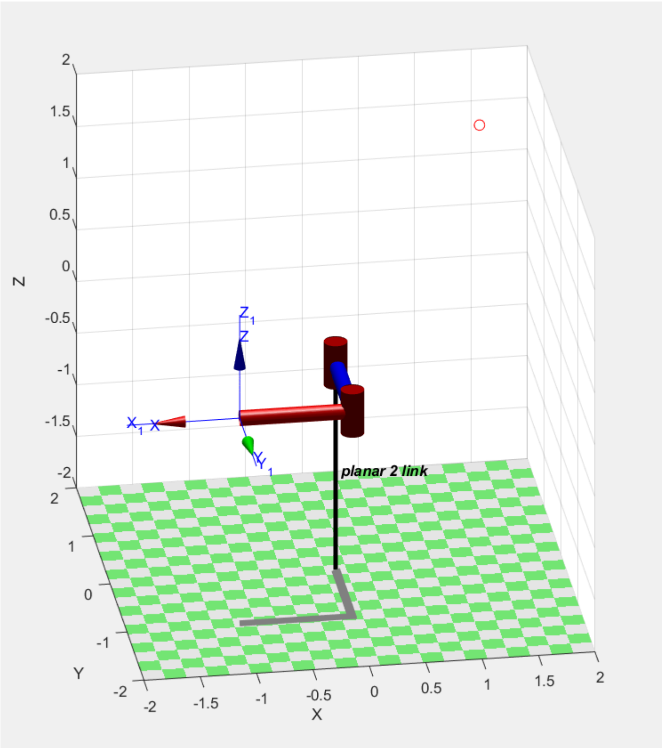
- Follow along with your lab demonstrator's presentation on how to connect your laptop to the UR5e via an ethernet connection.
- Follow along with your lab demonstrator's presentation of the example code provided. Find these on the RTDE github link.
  - RTDE: Example_0_Basic_Usage_1
  - RTDE: Example_0_Basic_Usage_2
  - RTDE: Example_0_Basic_Usage_3
  - RTDE: Example_1_Safety_Plane_Collision
  - RTDE: Example_2_Simple_square
  - RTDE: Example_3_Simple_Movec
  - RTDE: Example_4_Simple_Movej
  - RTDE: Example_5_Simple_Movel

<u>3.3. Rotations are non-commutative</u>

1. What does the term “rotations are not commutative in 3D” mean?
2. Demonstrate this using the RVC Toolbox (rotx,roty,rotz functions)

3.4. Poses in 3D

1. Import the “mdl_planar2” robot into matlab
    a. What other robots models can you import? Refer to the rtb manual.
2. Plot the robotic arm at a joint angle of [-pi/2 -pi/2]
3. Use the “scatter3” matlab function to plot a point “p” at the position [1.5, 1.5, 1.5]
4. Use the following “T = p2.fkine(q)” to calculate the forward kinematic solution to the end effector. This will provide you with the transformation frame of the end effector. You will learn more about forward kinematics in next week’s lecture.
5. Use the “trplot” rvc function to display this transformation frame on the plot with the planar2d robotic arm. Your plot should look something like the following:



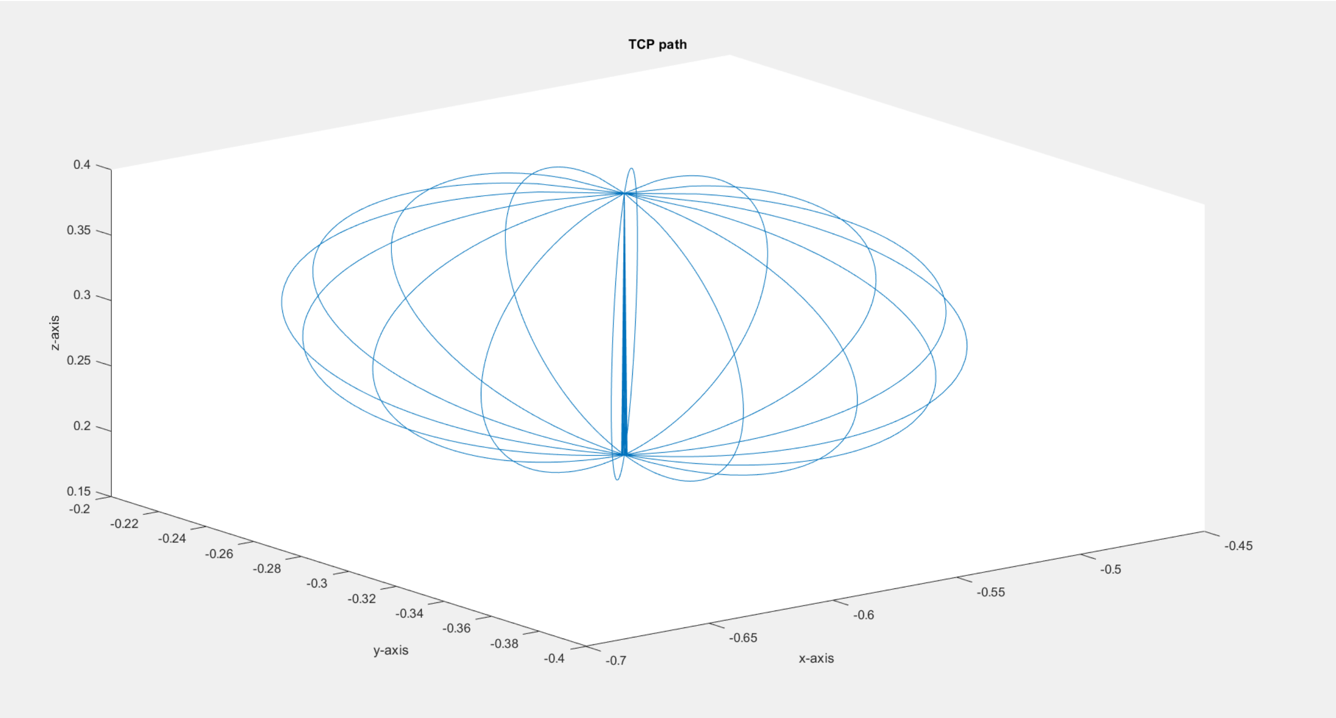
6. Calculate the position of the point “p” with respect to the frame of the robotic arm’s end effector.

3.5. Draw a 3D Sphere

Using the rtde interface, send commands to the UR5e to draw a sphere with a radius of 20 cm, with the centre of the sphere being at the robot’s home position.

- You should use movec.
- Rotate a point around the centre of the sphere to generate via-points using the RVC toolbox.
- Have a look at the “rotz()” function in the RVC toolbox.
- You may need to revise 2D and 3D geometry to remember how to perform pose transformations, please refer to the following videos if you need a refresher!
    - https://robotacademy.net.au/masterclass/2d-geometry/
    - https://robotacademy.net.au/masterclass/3d-geometry/

You output should look something like:



4. Post-lab

- Practice implementing tasks in URSim and the scripting interface for the ROBOT-2 assessment (coming soon, to be done in week 4).
- Further Reading:
  - RVC Textbook: Chapter 2, Representing Position and Orientation
  - Robot Academy Videos: 2D and 3D geometry videos