Homework 9

16-311: Introduction to Robotics

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Learning Objectives

1. Build up the basic concepts of inverse kinematics.
2. Understand the limitations of motion based on given mechanical system.

1 Workspace of PR Arm

Draw the workspace for a PR arm as shown in the following image. Show all the locations where the end effector can reach. Point out where there are 0, 1, and multiple solutions. Assume that the prismatic joint can have length between 0 and infinity. Assume that there are no joint limits for the revolute joint.

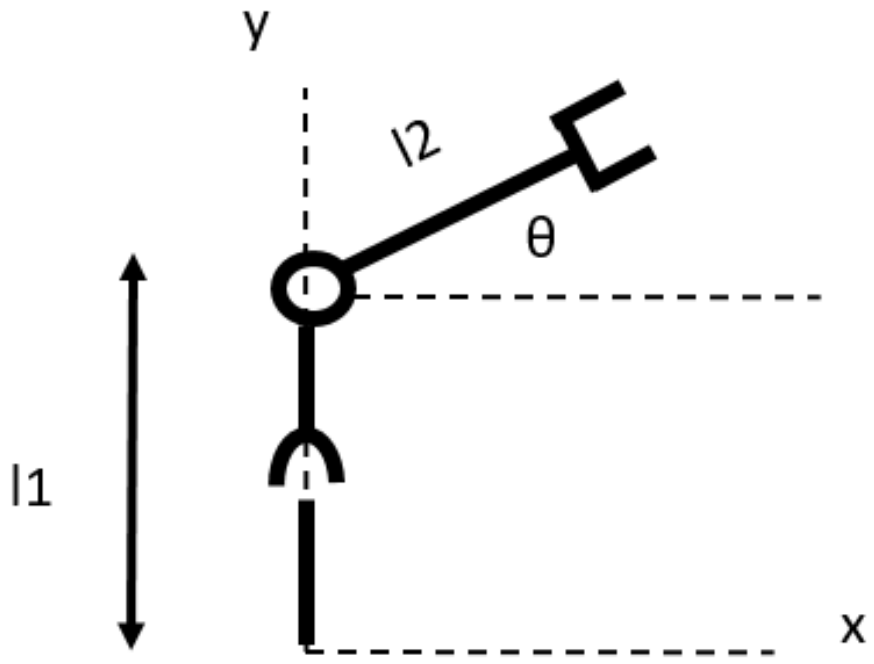

Figure 1: PR arm

2 Inverse Kinematics of PR Arm

Come up with the inverse kinematics for the same robot arm described in the previous section. Write an equation for the length of the prismatic and the angle of the revolute joint in terms of just the position (x,y) of the end effector. Let the second link be length l2.

3 Three Link Workspace

Draw the workspace for a revolute, revolute, revolute arm. Assume that you know that l1<l2<l3, but you do not know their relationship if you sum the joints. Using this information, draw both of the two possible pictures. Indicate were there are 0, 1 and multiple solutions.

4 Inverse Kinematics Reasoning

The mobile robot below can translate and rotate in any direction. On top of the thin column is an RR arm that has axes of rotation perpendicular to the axis of rotation of the mobile base. The location and orientation of the mobile base is (x, y, α). The two link manipulator is attached such that the axes of rotation are perpendicular to the page in the Side View image. The first joint of the two-link manipulator is at height h from the floor.

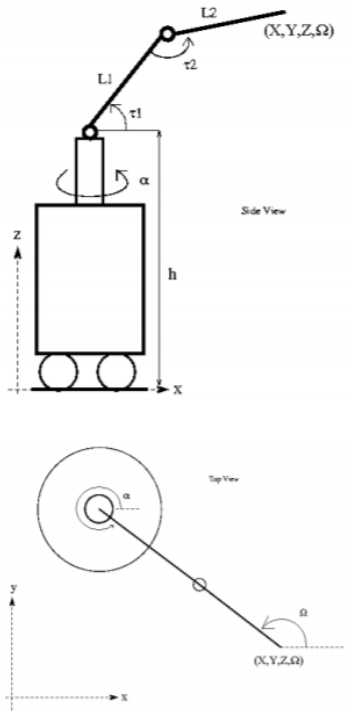

Figure 2: Image from Cameron and Book 1993.

For a desired X, Y, Z and Ω, how many solutions are there? Explain or illustrate your answer. (Hint: it depends on the desired location)

What To Submit

Submissions are due on Gradescope by the date specified in the Syllabus.

1. Create a .pdf file with the written answers ALL THE SECTIONS named hw9.pdf.

2. Ensure that your .pdf contain a picture for Part 1, two images for Part 3, and two equations for Part 2.