Homework 12

16-311: Introduction to Robotics

Contents

1 Learning Objectives

1. Build up the basic concepts of inverse kinematics.
2. Perform an example Lie Bracket.

2 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.

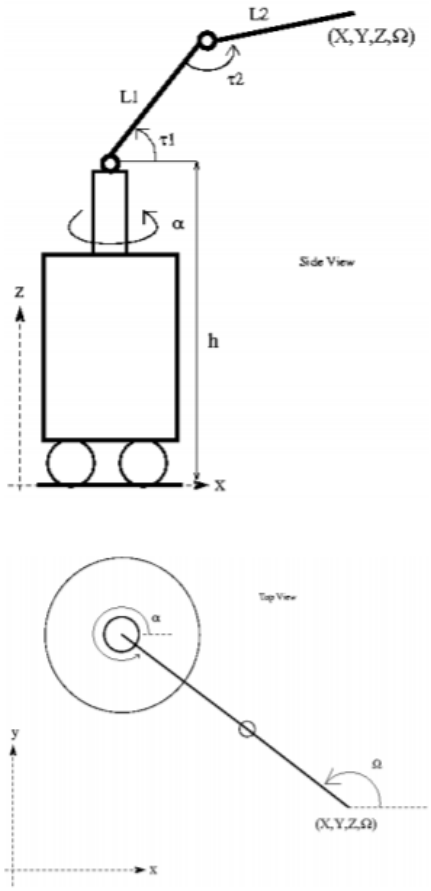

Figure 1: Image from Cameron and Book 1993.

For a desired X, Y, Z and Ω, how many solutions are there? Draw any two of the solutions for an example point in the robot's reachable area.

3 Lie Brackets

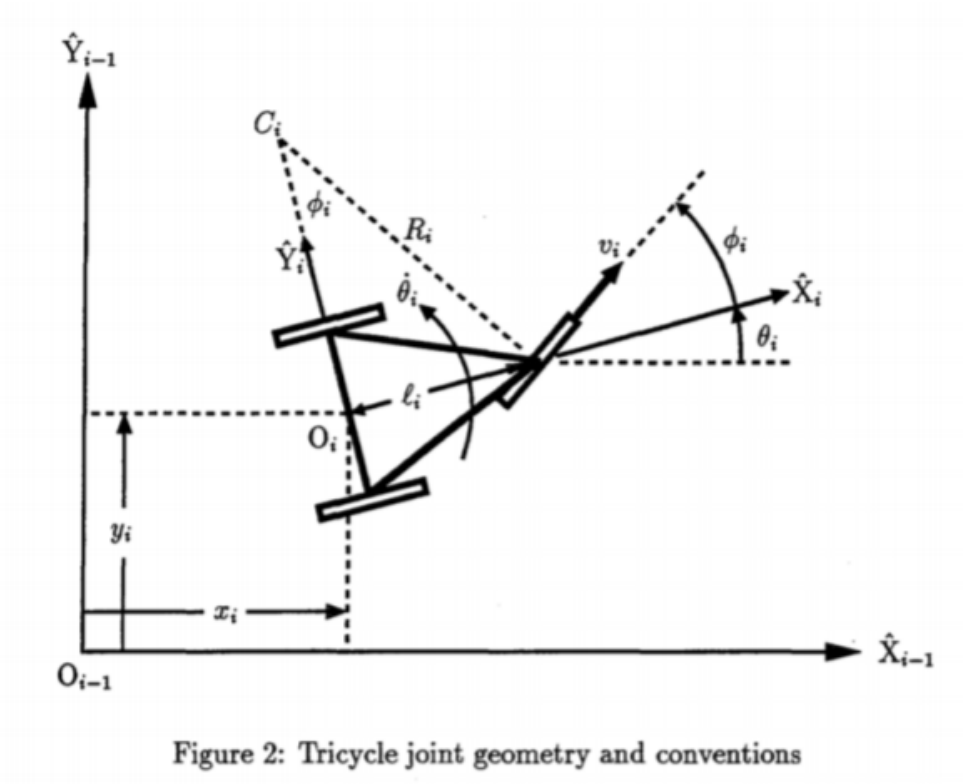

Figure 2: Image from Cameron and Book 1993.

3.1 States

In the tricycle above, what are the states of the system (there should be 4)?

3.2 Constraints

What are the constraints of this system if the system is not allowed to slip sideways? (q_1 and q_2)

3.3 Allowable Motions

What are the motions that this system allows (g_1 and g_2)?

3.4 Check

Are your allowable motions perpendicular to your constraints? Show this.

3.5 Check

Describe in words your g_1 and g_2?

3.6 Lie Bracket

Use Lie Brackets to determine any additional allowable motion(s).

3.7 Check

Show that these new allowable motion(s) are linearly independent of the previous allowable motions.

3.8 Meaning

Describe in words what this new motion is.

4 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 hw11.pdf.
2. Ensure that your .pdf contain an answer and two pictures for Part 2, and the solutions to all of the subquestions in Part 3.