Homework 10

16-311: Introduction to Robotics

Contents

Learning Objectives

1. Perform an example Lie Bracket.
2. Think critically about mobility options in robotics.
3. Think about UI design and how to improve and test it.

1 Lie Brackets

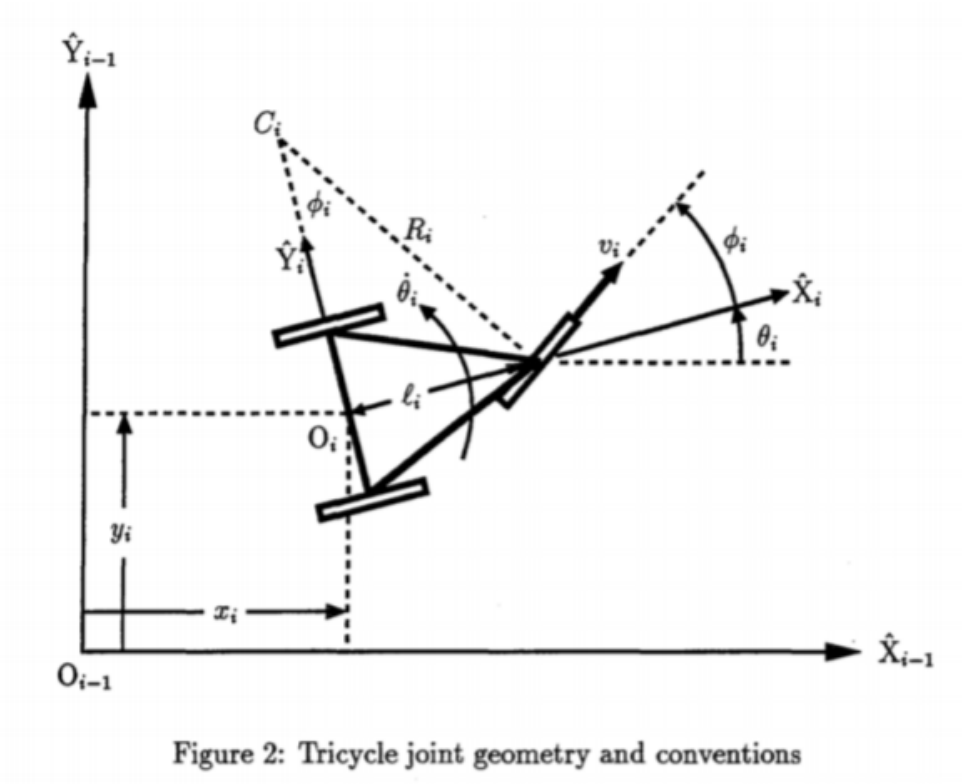


Figure 1: Image from Cameron and Book 1993.

1.1 States

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

1.2 Constraints

What are the constraints of this system if the system is not allowed to slip sideways? (w_1 and w_2)

1.3 Allowable Motions

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

1.4 Check

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

1.5 Check

Describe in words your g_1 and g_2?

1.6 Lie Bracket

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

1.7 Check

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

1.8 Meaning

Describe in words what this new motion is.

2 Mobility

2.1 Wheels

1. Name two benefits of wheels as they pertain to robotics.
2. Name one drawback of wheels as they pertain to robotics.
3. What are two different kinds of wheels you could use on a robot and why might you want to use them? List at least two types of wheels with one pro and con each.

2.2 Legs

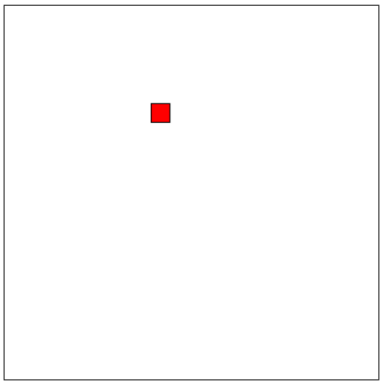
1. What are two advantages of legs for robots?
2. What is one disadvantage of legs for robots?
3. What are different set ups of legs and why might you use them? List at least two (hint think of the two different options from lab 8).

2.3 Other

1. What are some other methods of motion? List two and explain them.

3 HCI and User Interfaces

Download the following Python code: `https://drive.google.com/file/d/1TFygYoiHN_ZDXQPDmTlnar877dQiBQ5A/view?usp=sharing`. When you run this code, a "car" will appear on the screen and move up. You can make the car turn left by pressing the "l" key and make the car turn right by pressing the "r" key. The "f" key will increase speed, the "s" key will reduce the speed, and the "d" key will toggle between dark and light mode. The car will stop when its "battery" has been depleted.



Your task will be to design a user interface study to improve the current interface. You'll design two different options for driving controls, car graphics, battery level, and speed indication. You'll then design a feedback system for gathering information about which options are better and why.

1. List two ways you could map the "l", "r", "f", and "s" functions to new keys that that could potentially make use easier. Why did you choose these options?

2. Draw two new car graphics that could potentially improve use. Why did you choose these designs?

3. Design two battery indicators. Why did you choose these designs?

4. Design two speed indicators. Why did you choose these designs?

5. Imagine you're running a study to determine which of the above designs is best. How would you gather feedback from your participants (survey? interview?) and why?

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 hw10.pdf.

2. Ensure that your .pdf contain an answer and two pictures for Part **??**, and the solutions to all of the subquestions in Part 1.