Homework 10

16-311: Introduction to Robotics

Last Updated: 12 April 2017

Contents

1 Learning Objectives

1. Develop intuition for relative translations and rotations.
2. Practice expressing movements in matrices.
3. Practice expressing end effector location in terms of joint angles.

2 Basic translations and rotations

Draw the intermediate motions for a wedge that undergoes Trans $(Y, \Delta y_1)$ Rot (Z, θ_1) Trans $(Y, \Delta y_2)$ Rot (X, θ_2). Choose and state reasonable angles and translations. You can use a computer (e.g. with MATLAB) or hand-draw these plots. All movements are relative.

3 Homogeneous Transformations

A can starts out with the center of its base on the origin. It has a radius of 1 cm, and a height of 3 cm. The homogeneous transformation matrix H is applied to the can.

1. Express this single matrix as a product of intermediate matrices where each matrix is either a rotation or translation about a single axis.

2. Express each of the matrices from the previous part in words (ex. "Rotation by 10 degrees about the z axis, Translation by 100 units on the y axis, etc.")

$$H = \begin{bmatrix} 1 & 0 & 0 & -2 \\ 0 & \sqrt{2}/2 & \sqrt{2}/2 & 5 \\ 0 & -\sqrt{2}/2 & \sqrt{2}/2 & 9 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

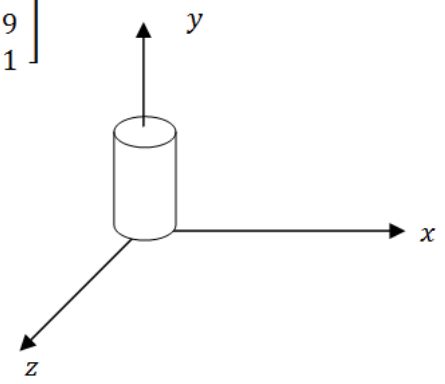

Figure 1: Sample can and homogenous transformation.

4 Forward Kinematics

Derive the forward kinematics for the following RRP arm with base at the origin. Express the end effector location (x,y and θ) in terms of the known quantities listed in the picture.

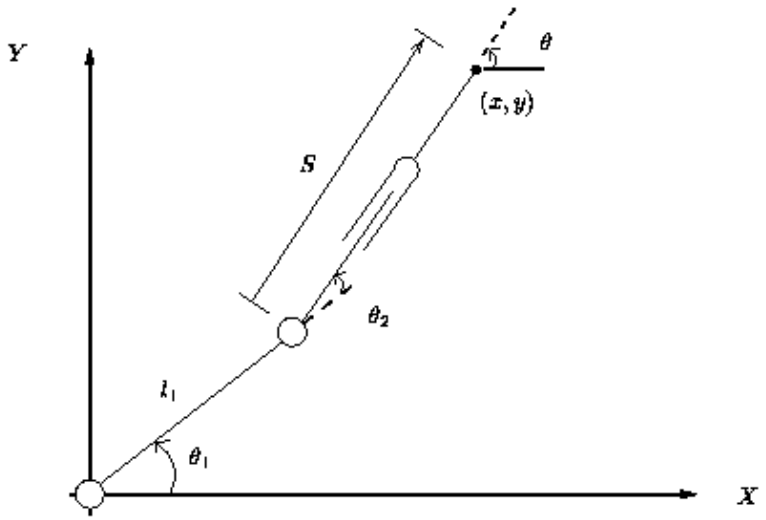

Figure 2: RRP arm.

5 What To Submit

Sumbissions are due on Autolab 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 contains all drawings for Part 2, answers for Part 3 and equations for x, y and θ for Part 4.