Homework: v-rep Assignment 2

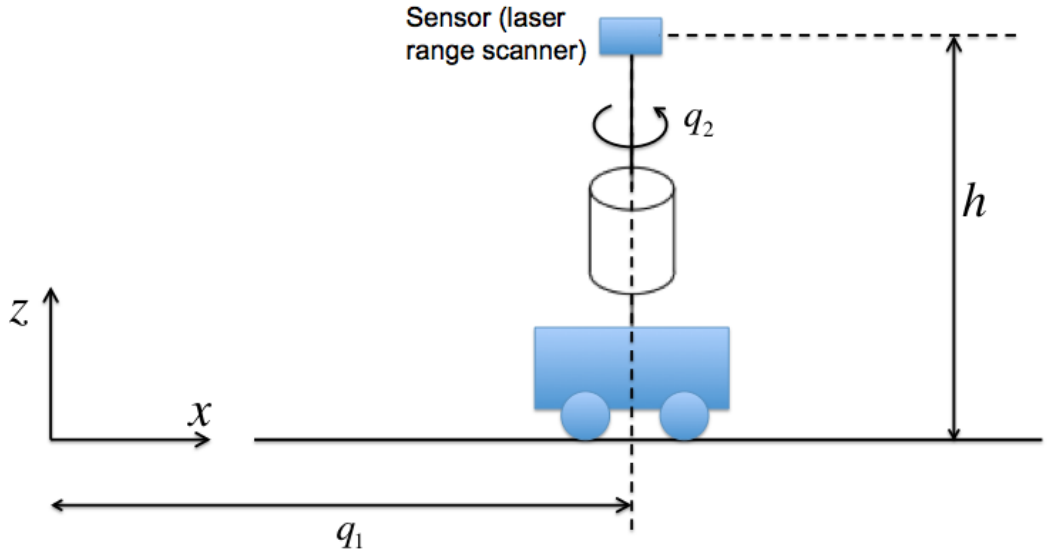
1. Consider the RR (revolute-revolute) manipulator from the v-rep Assignment 1 in `http://crrl.poly.edu/EL5223/vrep_hw1.html`.

   (a) Write a Matlab function to compute the forward kinematics of the manipulator considering the center of the third cuboid (i.e., second link of the manipulator) as the end effector. Using the remote API (`http://www.coppeliarobotics.com/helpFiles/en/remoteApiOverview.htm`, send commands from Matlab to set the angular positions of the two joints to some desired values and read back the position of the center of the second link. For several sets of joint angles, verify that your Matlab function for the forward kinematics returns the same end-effector position as read from v-rep.

   (b) Now, consider the task of making the end-effector track a given trajectory (e.g., a straight line). Write a Matlab function (inverse kinematics) to find the joint angles for a given desired end-effector position. Using the v-rep remote API, send joint angle commands to make the end-effector track a specified line. Read back the end-effector position from v-rep and verify that the end-effector position does indeed follow the specified trajectory.

   Note: v-rep supports several languages with the same remote API across all languages. If you are more familiar with another language than Matlab, you can use that programming language instead if supported by v-rep.

2. Consider the prismatic-revolute manipulator shown below. A distance sensor (a laser range scanner) is mounted on the top of the second link. This laser range scanner provides readings of distances along various directions from the sensor or equivalently provides three-dimensional readings of point locations (relative to the sensor) in the environment (i.e., if a measurement direction from the sensor is v and the distance reading is d, then the three-dimensional reading of a point location in the environment relative to the sensor is dv). Since the measured point locations are relative to the sensor, they need to be converted to a world frame (i.e., frame 0 or base frame) to build an environment map. If the joint variables for the manipulator shown below are q_1 and q_2 and a measured point location relative to the sensor is p, then write the corresponding point location relative to the base frame. Explain how you would use a sequence of readings from the laser range scanner to build a map of the environment (note that q_1 and q_2 would, in general, be varying with time while the sequence of readings is being obtained).



3. A v-rep simulation scene with the prismatic-revolute manipulator, a laser range scanner mounted on the manipulator, and a simple surrounding environment (with three objects: two cuboids and one cylinder) is at: `http://crrl.poly.edu/EL5223/simple_environment.ttt` . An example Matlab program to send commands to the prismatic and revolute joints and get readings from the laser range scanner is at: `http://crrl.poly.edu/5223/sim_manipulator.m` . Based on your answer to Question 2 above, write a program (in Matlab or any other language of your choice) to build a map of the environment based on the measurements from the laser range scanner and make a 2-D or 3-D plot of the constructed environment map.