

This homework is to get you familiar with Drake and practice the PoE and velocity kinematics theory taught in class. Depending on your background, you may want to watch the video tutorial on Mujoco.

Let us consider the robot shown in Fig.4.3 of Modern Robotics.

1. Use Mujoco to build this robot model (similar to the example we discussed during class) and show the snapshots of Mujoco visualization at three different sets of joint positions.
2. Write your own forward kinematics function (using PoE) to compute the pose of the end-effector frame (i.e. frame {3}) relative to the world frame {0}. Test your function for a few different sets of joint positions and compare your results with Mujoco's built-in function
3. Write your own function to compute the geometric Jacobian of the end-effector frame (i.e. frame {3}) expressed in the world frame {0}. Test your function for a few different sets of joint positions and compare your results with Mujoco's built-in function
4. Let q be a point attached to frame {3} with local coordinate ${}^3q = (1, 2, 3)$.
 - Derive the (analytic) Jacobian ${}^0J_a(\theta)$, i.e., ${}^0\dot{q} = {}^0J_a(\theta)\dot{\theta}$. Show all your steps.
 - Write a function in Mujoco to implement your formula. Test your function for a few different sets of joint positions/joint velocities, and compare your results with the Mujoco's built-in function.

Note: You can use the Modern robotics package in your own implementations of the above problem: <https://github.com/NxRLab/ModernRobotics>