

Robotics with MuJoCo, HW 5

Topics: Inverse kinematics

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1. Drawing an astroid with a three link manipulator:

Consider a three-link manipulator with link lengths of $\ell_1 = 1$ m, $\ell_2 = \ell_3 = 0.5$ m and joint angles θ_1 , θ_2 , and θ_3 as shown in Fig. 1 (left side). Your goal is to get the tip of the three-link manipulator to draw an astroid, an example is shown in Fig. 1 (right side). **While drawing the astroid, the link QR should be vertical or along the y-axis.**

The equation of an astroid in parametric form is given by

$$\begin{aligned}x &= x_0 + a \cos^3 \theta \\y &= y_0 + a \sin^3 \theta\end{aligned}\tag{1}$$

where x_0 and y_0 is the center of the astroid and a determines the size of the astroid. Feel free to choose appropriate values for these parameters.

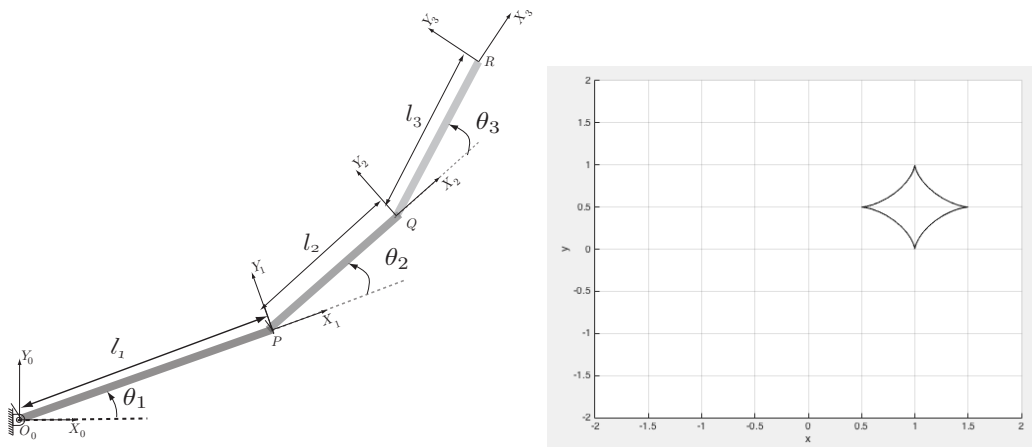


Figure 1: Manipulator and an astroid

HINT: Here you want to regulate three things: the x-position and y-position of the end-effector, and the z-orientation of the end-effector with respect to the world frame. You would need the Jacobian related to the x, and y position (1st and 2nd row in `jacp` in `mj-jac`) and z-orientation (third row in `jacr` in `mj-jac`). The Jacobian you populate will be of dimension 3×3 . If the end-effector moves in the x-z plane these rows will change to first and third row of `jacp` and second row of `jacr`. Click this link for more info. about `mj-jac`: <https://mujoco.readthedocs.io/en/latest/APIreference.html#mj-jac>