Robotics I

April 1, 2015

Consider the planar 2R robot in Fig. 1. Determine a *minimum time* trajectory that brings the robot end-effector from point P_{in} to point P_{fin}, with zero initial and final velocity, keeping into account the following constraints on the velocity and acceleration of the two joints:

$$|\dot{q}_i| \leq V_i, \qquad |\ddot{q}_i| \leq A_i, \qquad i = 1, 2.$$

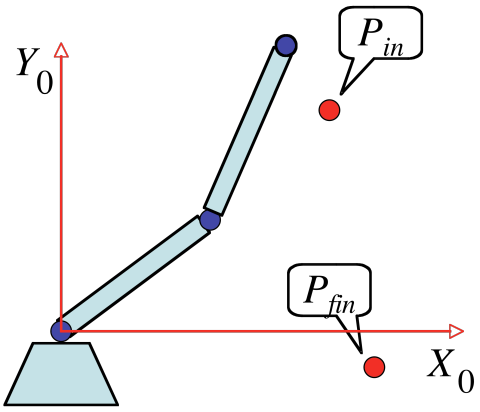

Figure 1: A planar 2R robot performing a point-to-point task

Describe in an algorithmic way the procedure to follow in order to determine the optimal solution. Provide the value of the minimum time and sketch the joint velocity profiles for a robot with the following numerical data

$$\begin{aligned} \ell_1 &= \ell_2 = 2.5 \text{ [m]}, \\ V_1 &= 1 \text{ [rad/s]}, \quad A_1 = 2 \text{ [rad/s}^2\text{]}, \\ V_2 &= 2 \text{ [rad/s]}, \quad A_2 = 1.5 \text{ [rad/s}^2\text{]}, \end{aligned}$$

that needs to execute the following motion task:

$$P_{in} = \begin{pmatrix} 4 \\ 3 \end{pmatrix} \text{ [m]} \qquad \Rightarrow \qquad P_{fin} = \begin{pmatrix} -2 \\ 0 \end{pmatrix} \text{ [m]}.$$

How would the solution change in case we additionally request a *coordinated* robot joint motion, using the same class of velocity and acceleration time profiles for both joints?

[120 minutes; open books]