Robotics I

July 15, 2013

For a 2R planar robot having links of equal length $\ell_1 = \ell_2 = 0.5$ [m], consider the rest-to-rest motion defined by the joint velocity profiles $\dot{\boldsymbol{q}}(t) = \begin{pmatrix} \dot{q}_1(t) & \dot{q}_2(t) \end{pmatrix}^T$ shown in Fig. 1. The motion starts at $t = 0$ from $\boldsymbol{q}(0) = \begin{pmatrix} -30^\circ & 60^\circ \end{pmatrix}^T$ and ends at $t = T$. The trajectory parameters are:

$$T = 2 \text{ [s]}, \qquad T_{s,1} = 0.5 \text{ [s]}, \qquad T_{s,2} = 1 \text{ [s]}, \qquad V_{max,1} = 50 \text{ [°/s]}, \qquad V_{max,2} = -90 \text{ [°/s]}.$$

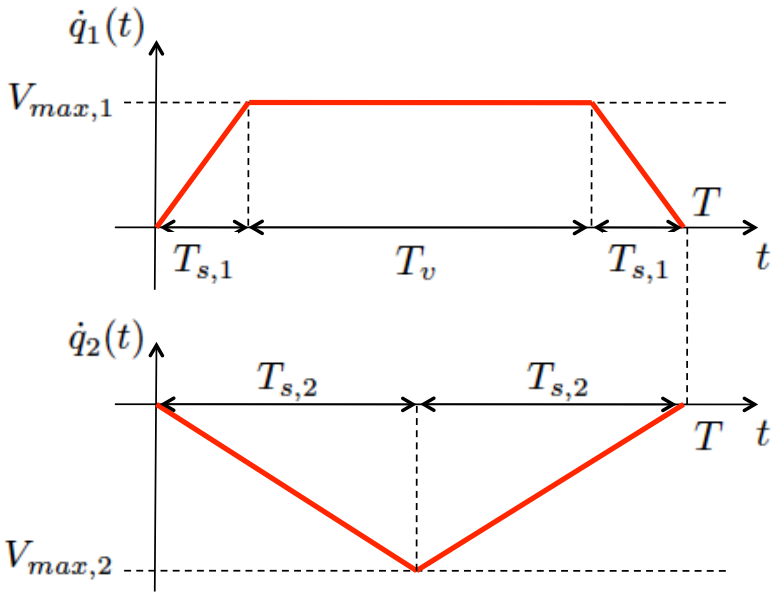

Figure 1: Velocity profiles of joint 1 (top) and joint 2 (bottom)

i) Determine the displacement of both joints at the end of motion and the Cartesian distance between the initial and final position $\boldsymbol{p}$ of the robot end-effector. Does the robot cross a singular configuration?

ii) Compute the velocity $\dot{\boldsymbol{p}}$ and acceleration $\ddot{\boldsymbol{p}}$ of the robot end-effector at $t_1 = T/10$ and $t_2 = T/2$. Sketch the robot configuration and the two vectors at these instants of time.

[120 minutes; open books]