The robot's state consists of its position and velocity for each joint. The position of the robot is represented as $\mathbf{q}_{err}$, as the position error from the goal position.

$$\mathbf{x} = \begin{bmatrix} \mathbf{q}_{err} \\ \mathbf{q}_{vel} \end{bmatrix} \tag{1}$$

$$\dot{\mathbf{x}} = \begin{bmatrix} \mathbf{q}_{vel} \\ \mathbf{q}_{acc} \end{bmatrix} = \begin{bmatrix} \mathbf{q}_{vel} \\ \mathbf{M}^{-1}(\tau - \mathbf{C}) \end{bmatrix} \tag{2}$$

where

$\mathbf{M}$: inertia matrix
τ : torque applied by joints
$\mathbf{C}$: gravity, friction, and other external effects

$\mathbf{C}$ is calculated by Pinocchio library, it is completely separated from QP problem.
For the QP formulation we need to construct a different state. To start, here is an example QP formulation:

$$\begin{aligned} &\textit{minimize} && \frac{1}{2}\mathbf{x}^T\mathbf{P}\mathbf{x} + \mathbf{q}^T\mathbf{x} \\ &\textit{subject to} && \mathbf{l} \leq \mathbf{A}\mathbf{x} \leq \mathbf{u} \end{aligned}$$

The new state for QP will be:

$$\mathbf{x} = \begin{bmatrix} \mathbf{q}_{err}^{t+1} \\ \mathbf{q}_{vel}^{t+1} \\ \mathbf{u} \end{bmatrix} \tag{3}$$

Robot dynamics in the QP problem will be very simple:

$$\begin{aligned} \mathbf{q}_{err}^{t+1} &= \mathbf{q}_{err}^{t} + \mathbf{q}_{vel}^{t+1}.T \\ \mathbf{q}_{vel}^{t+1} &= \mathbf{q}_{vel}^{t} + \mathbf{M}^{-1}.\tau.T \end{aligned} \tag{4}$$

where

T : time step between each controller iteration
: the superscripts mean time step t and $t+1$

We can write the dynamics as linear constraints as follows:

$$\mathbf{l} = \mathbf{u} = \mathbf{A}\mathbf{x} \tag{5}$$

$$\mathbf{l} = \mathbf{u} = \begin{bmatrix} \mathbf{q}_{err}^{t} \\ \mathbf{q}_{vel}^{t} \\ \mathbf{u}_{lim} \end{bmatrix} = \begin{bmatrix} 1 & -T & 0 \\ 0 & 1 & -\mathbf{M}^{-1}.T \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mathbf{q}_{err}^{t+1} \\ \mathbf{q}_{vel}^{t+1} \\ \mathbf{u} \end{bmatrix} \tag{6}$$

The cost will be:

$$\mathbf{P} = \begin{bmatrix} \mathbf{I} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} \end{bmatrix} \tag{7}$$

$$\mathbf{q} = \mathbf{0} \tag{8}$$