LAB2

EL2700 - Model Predictive Control

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1 Vehicle model

The first step of designing a good MPC is to obtain a good model of the system which is to be controlled.

1.1 Continous time system

The continous time model used will be one derived by the bicycle model of the car. Given the internal states $z(t) = [x(t), y(t), v(t), \psi(t)]^T$ and the inputs $u(t) = [a(t), \beta(t)]^T$, the system dynamics can be expressed on the form $\dot{z}(t) = f(z(t), u(t))$ as:

$$\underbrace{\dot{\begin{bmatrix} x(t) \\ y(t) \\ v(t) \\ \psi(t) \end{bmatrix}}}_{\dot{z}(t)} = \underbrace{\begin{bmatrix} v(t)\cos(\psi(t) + \beta(t)) \\ v(t)\sin(\psi(t) + \beta(t)) \\ a(t) \\ \frac{v(t)}{l_r}\sin(\beta(t)) \end{bmatrix}}_{f(z(t), u(t))} \tag{1}$$

1.2 Discrete time system

In order to implement the MPC the model needs to be discretizised. This is here done by the explicit Euler method. Introducing the sampling time T_s and the discrete time variable $k = T_s t$ the discretization yield the system:

$$z(k+1) = z(k) + T_s f(z(k), u(k)) \tag{2}$$