The Model

Model is based on Kinematic Vehicle Model. The following are the states [x,y,ψ,v]. L_f is a physical characteristic of the vehicle which measures the distance between the front of the vehicle and its center of gravity , and [δ,a] are the actuators.

State Update equations

$$x_{t+1} = x_t + v_t * cos(\psi_t) * dt$$

$$y_{t+1} = y_t + v_t * sin(\psi_t) * dt$$

$$\psi_{t+1} = \psi_t + \frac{v_t}{L_f} * \delta_t * dt$$

$$v_{t+1} = v_t + a_t * dt$$

Cross Track Error

$$cte_{t+1} = f(x_t) - y_t + (v_t * sin(e\psi_t) * dt)$$

Orientation Error

$$e\psi_{t+1} = e\psi_t + \frac{v_t}{L_f} * \delta_t * dt$$

Parameters

Number of time steps N is 20. dt should be as small as possible 0.05 works well as it can also account for 100ms delay .Time horizon T in this case would be 20*.05 = 1 Sec. Any larger horizon doesn't improve performance however the computational cost will increase. The target speed is set for 60mph.Higher speed increases the risk for the passengers.

The weights for the costs are: 1, 1, 1 for the reference states and 1, 40, for the actuators and 800, 1 for sequential actuation. Previous values tried were 1 for all 500 for change of delta as explained in the lecture.

Way points

The way points are used to fit to a third order polynomial. Before fitting way points are transformed from the map coordinates to the car coordinates.

Latency

To handle 100ms delay, actuation is chosen with delay of 100ms.