The Model

The kinematic model is composed from the following (x coordinate, y coordinate ,vehicle orientation, velocity and cte). The actuator output is the acceleration and steering angle.

In our calculation we use the previous state(t) to calculate next step(t+1). The model try to predict the trajectory through the following steps:

1. Set everything required by MPC
2. Define Vehicle Model and constraints(solve function)
3. Define upper and lower bound for the constraints
4. Calculate the cost function(we need to optimum this function)

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

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

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

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

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

$$e\psi_{t+1} = \psi_t - \psi des_t + (\frac{v_t}{L_f} * \delta_t * dt)$$

Timestep Length and Elapsed Duration (N & dt)

The values chosen for N and dt are 12 and 0.05, they are tuned manually using the fact that the more dt smaller the much better

When I tested 10 and 0.01 the car get out from the lane

Polynomial Fitting and MPC Preprocessing

We transform the coordinates from global to local, also we assume that the vehicle at the origin. Then we use Polyfit function to get coeffs(3 rd order equation)

Model Predictive Control with Latency

Latency is taken into account by constraining the controls to the values of the previous iteration for the duration of the latency. Thus the optimal trajectory is computed starting from the time after the latency period. This has the advantage that the dynamics during the latency period is still calculated according to the vehicle model.

Implementation

Check this video

https://youtu.be/fgzTZEOb8II