

Reflection on P, I, D parameters of PID Controller:

The goal of the project is to design a controller that which could drive the car in simulator without takes it off the road. To achieve the goal a PID Controller is used. PID Controller operates on three parameters. 1) Kp (Proportional Parameter), 2) Kd (Differential Parameter) and 3) Ki (Integral parameter). Below is an explanation on how the parameter values are chosen.

It should also be noted that, the velocity of the car is fixed to be 30mph.

1) Kp (Proportional Parameter):

This parameter drives the car towards its target, center of the lane.

Assigning some value only to this parameter and setting the other two parameters to zero, the controller becomes a P Controller (Proportional Controller).

I experimented with various values for the Kp parameter. If the value is chosen to be too small the car reaches center of the lane very slowly, and if its value is set too high, the car's movement becomes too wavy around the center of the lane. Either ways, even at an optimal value the car still moves in a wavy path around the center of the lane, in other words it never converges. So, using just a P Controller is not a good option.

2) Kd (Differential Parameter):

By assigning some value to Kp and Kd and setting Ki to zero, the controller becomes PD Controller.

As explained above P Controller always generates a wavy path, to reduce this wavy nature and help the controller converge to the target position the Kd parameter is helpful.

I experimented with various values of Kd. It is observed that, for the car to be able to recover and get back to the center of the lane the Kd value should be chosen sufficiently high.

3) Ki (Integral Parameter):

This parameter helps in reducing the effect of bias on the path generated by the controller. For example, if the wheels of a car are mis-aligned, the path generated by a PD Controller would not be a good one. Thus, the PID controllers helps in reducing the error accumulated over time.

In case of the simulator, there is no such bias associated with the wheels of the car. Thus, the value of Ki is chosen to be approximately 0.

Kp, Ki and Kd values chosen before tuning the parameters:

Kp = 0.10

Ki = 0.001

Kd = 0.5

Parameter Tuning:

To tune the parameters that I manually chose, as mentioned above, I used the Twiddle algorithm taught in the lecture.

Parameters that the Twiddle Algorithm returned are $K_p = 0.45$, $K_i = 0.004$ and $K_d = 1.92$. But, with these parameters, I observed that the path became more wavy than before. So, I have set the value of $K_p = 0.10$, as a result the path is much smoother than before.

Thus, the final values of the parameters are:

$$K_p = 0.10$$

$$K_i = 0.004$$

$$K_d = 1.92.$$