

# PID Controller

## Objective:

The goal is to move the car within the lanes and correct the movement using PID controller

## Input data:

1-from simulator: CTE Cross track error (the distance error) and the velocity in mph

2-from user: PID gains(weights) where P is the proportional controller, I is the integral controller and D is the Differential controller

## Output data:

the steering angle which shall be within  $[-1,1]$  and it's calculated by the following equation:

$$\text{steering angle} = k_p * p\_error + k_i * i\_error + k_d * d\_error$$

where:

$k_p$ : gain of proportional controller

$k_i$ : gain of integral controller

$k_d$ : gain of differential controller

$p\_error$ : error of proportional controller which is the new CTE

$i\_error$ : error of integral controller which is the sum of all CTE

$d\_error$ : error of differential controller which is the diff between the current CTE and the previous one

## Reflection:

I surfed the internet for how to select the PID parameters and this is the method I used to get these parameters

1. Set all gains to zero.
2. Increase the P gain until the response to a disturbance is steady oscillation.
3. Increase the D gain until the the oscillations go away (i.e. it's critically damped).
4. Repeat steps 2 and 3 until increasing the D gain does not stop the oscillations.
5. Set P and D to the last stable values.
6. Increase the I gain until it brings you to the setpoint with the number of oscillations desired (normally zero but a quicker response can be had if you don't mind a couple oscillations of overshoot)

## Effect of Every component:

1-The p component decrease the rise time while it causes overshoot

2-The d component make small effect of the rise time while it decrease the overshoot, so we can consider that P and D are equalizing each other

3-The I component decrease the rise times but also increase the overshoot, settling time

I chose to depend more on P,d components because increasing I causing unstable steering angle so I used small p component value with high d component value and use very small value for the I component