

## CarND PID Control Project

### P, I, D Tuning

The aim of this project was to tune the P, I and D parameters to ensure the vehicle in the simulator drives within the track and steers back on the track whenever it is almost driving off at acute steering angles. P component is the proportional gain constant, it is the period and magnitude of the step response, the I component is the integral gain constant, it is used to correct the error to the time step function and the D component is the derivative gain constant which is used to smooth out the oscillation of the system. The P, I, D components of the controller were tuned manually by experimentation.

- When the parameters were set to  $P = 0$ ,  $I = 0$  and  $D = 0$ , the vehicle drives straight on the road. The PID control had no effect on the vehicle's steering.
- When the parameters were set to  $P = 1$ ,  $I = 0$  and  $D = 0$ , the vehicle overshoots and tries to drive off the road thereby resulting in a lot of swerving.
- When the parameters were set to  $P=1$ ,  $I=1$ , and  $D = 0$ , the vehicle continues to overshoot with also with a lot of swerving.
- When the parameters were set to  $P = 1$ ,  $I = 0$ , and  $D = 1$ , the vehicle continues to overshoots but with minimal swerving, it appears that a higher D value improves the performance.
- After numerous experimentation on the parameters, the parameters were set to  $P = 0.085$ ,  $I = 0.0$  and  $D = 2.0$ , The final value was arrived by manual adjusting the parameters till the performance improved significantly. The I value was reduced to zero to produce a better performance and increasing the D value maintained a low maximum CTE.

### Throttle Setting

The throttle was set per the current CTE and the steering angle. A low range of steering angle and low CTE indicated the road was straight, a higher steering angle range indicated there was a turn and a lower steering angle was set for it, and huge steering angle indicated the vehicle needed to slow down so the brake was applied. The car achieved a max speed of 48 MPH.