# Writeup- Term-2 PID controller project

PID controller stands for proportional, integral, derivative. By using these 3 parameters as weights for cross track error(CTE), we estimate quite accurately our steering angle.

These parameters need fine tuning which can be done manually or by using some optimization technique like twiddle or gradient descent. In this project I have performed **manual tuning** of parameters **Kp**, **Ki** and **Kd**.

**P** in PID is the proportional term and hence by **Kp** coefficient tells us how much to change the steering in proportion to the CTE.

**D** is the derivative term (helps in smooth transistion) and so **Kd** helps us to avoid overshooting and hence a lot of oscillations while driving.

**I** is the integral, giving sum of all previous CTE's. This term is useful to get around system bias while driving. **Ki** coefficient is represented as the integral term.

**Attempt 1:**

I started out with just playing with non-zero negative values of **Kp** keeping other 2 constants.

Please see video attempt 1 using **Kp** as **-0.5.** This resulted in car moving forward but with lot of oscillations and finally going off track. I experimented with this a little. This was expected as Kd was 0 and hence nothing to prevent the oscillations.

**Attempt 2:**

For Kd, I started with **-0.5**. I got further ahead, with minor oscillations but, during the steep turn the car started going off track. Please see attempt 2 with **Kp = Kd = -0.5. Ki = 0.** This indicated I must tune the Kp to probably a higher value, so that my steering responds faster to high CTE.

After this I spent several hours to fine tune the parameters. Ki did not seem to matter much as I guess there is very low, if any, bias to the car in simulator. So I kept it very low

My **final parameters** were:

**Kp= -0.15**

**Ki= -0.00001**

**Kd= -0.9**

Please see **final attempt**, where car goes around the curve pretty well without going off track