PID Control

PID(Proportion-integral-derivative) controller is widely used in control systems due to ease of implementation. PID model continuously calculate CTE(cross track error) calculated based on SET POINT. CTE can be defined as different between setpoint and measured point. Correction is applied in three terms(proportion(P), integral(I) and derivative(D)).

P(proportion) – This term responds for CTE. If CTE is positive and large, P term will provide response in proportion to large CTE and generally called Proportional gain(K_p). Due to proportional level of response, there will large swings and car will swing a lot on the road.

I(Integral) – Integrate Past CTEs and will accumulate over time. This is primary used to minimize constant error using integral coefficient(K_i).

D(derivative) – This term dampens the effect of P using current rate of change in CTE. If rate of change is very high, Derivative(K_d) will act opposite to the proportional gain. This will smoothen the swings caused by proportional factor.

Steps for choosing parameters:

Step#1: Implemented Twiddle algorithm in PID class. Entire function was written in function Twiddle(double cte). I tried to integrate with the main function that will tuning the parameters on the fly and also whenever, error crosses the threshold, twiddle algorithm will be invoked and tuned.

This approach failed because car was veering off before parameter get tuned.

Step#2: After observing the pattern in PID class and reading thru forums, I observed that K_p, K_i & K_d are in range of

K_p - [0.1 to 1]

K_i - [0.0001 – 0.01]

K_d – [3 – 14]

Initially, only K_p was value was set to 0.1. however, car was swinging on the road and veered off as expected.

Link: https://youtu.be/jR6hErYlIuQ

Therefore, I took random value of 0.1, 0.01, 3. This kept the car in the track. Now, I enabled Twiddle function that was programmed earlier and program was able to tune these parameters.

Kp = 0.115711, Ki =9.6854e-05, Kd = 1.1903.

Below is the records with above tuned parameters.

Link: https://youtu.be/iblACCtSo5U

Car was able to complete the track and also minmized wobbling.