# PID controller project

This report aims to explain the effects of the PID parameters. Actually, one of the most problem of a PID controller is the identification of the proportional ($K_p$), integral ($K_i$) and derivative ($K_d$), constants.

To identify these set of parameters properly, I proceeded in two steps. Firstly, I observed the effect of each parameter separately and tuned all of them manually. I observed that a controller with only the derivative parameter can barely adjust the car positions, because a single proportional controller always entailed undesirable oscillations, which made the car to get out of the road. So, in order to reduce the oscillation, I changed the value of $K_d$ with the purpose of reducing this oscillatory effect. Finally, I tuned the integral constant in order to get rid of bias and offset. At the end of this first step, I arrived in the following parameters:

$$K_d = 0.1$$

$$K_i = 0.004$$

$$K_d = 3.0$$

As a second step of the tuning procedure, I implemented the Twiddle algorithm to optimize the parameters of the PID controller as explained in the lecture. Since I could not reset the car position in each algorithm's iteration, I used a fixed window. In other words, I fixed the number of samples to calculate the cross error track (CTE) of the system and use the value of CTE to update the $K_p$ , $K_d$ and $K_i$. As a result, I achieved better parameters of the PID controller, as specified bellow:

$$K_p = 0.2438$$

$$K_i = 0.00046$$

$$K_d = 3.3$$