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Udacity Self-Driving Car Term 2
PID Controller Reflection

Reflection
The goal of this project was to build a PID controller that would enable a simulated car to drive itself around a track, taking only the “cross-track error” as its input. By combining proportional, integral, and differential control, I was able to do this successfully.

Parameters

Proportional
The first parameter I added was P, or proportional control. This sets the steering angle to a value that is directly proportional to the cross-track error. The bigger the error, the bigger the corrective steering angle.

My initial values for the P parameter were wildly too high or low, and as a result the car either quickly spun off the track or drove in a straight line without turning. But with some tuning, I was able to get the car to successfully make it down the first straightaway, but it quickly started to overshoot and steer back and forth in more wildly increasing angles. P control is not enough.

Differential
The second parameter I added was D, or differential control. The goal of D is to damper the effect of P, and sets the error value not to the cross-track error, but by the difference between the current error and the error in the previous step. If it’s improving, it starts to apply a corrective steering factor so the car doesn’t overshoot.

My initial D values were too small and didn’t do enough to correct the overshooting, but eventually I settled on a value that allowed the car to drive partially around the track without overshooting. However, the car was not able to successfully make it around the first sharp turn.

Integral
The final parameter I added was I, or integral control. The goal of I is to apply an increasingly strong error to correct it if P and D aren’t doing enough, which it does by cumulating the error over time.

My initial I values were way too high. Because this factor is being multiplied by the sum of all errors over time, this value must be small or it will dominate too strongly. But by adding a small I value, the car was able to make it around all the sharp turns on the track and complete a full lap.

Final values:
P = 0.1
I = 0.0002
D = 1.0