

WriteUp P8: PID Controller

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Introduction

This document is the model documentation for PID Control project. This document is part of the project submission located at <https://github.com/mmarouen/CarND-PID-Control>

I ran the code without red flags on my local machine using the following configuration:

Graphics: **800 x 600**

Quality: **simple**

Parameters selection

I follow a “grid search” principle to find the best combination of parameters.

For **P** and **D** try 3 possible values: {**0.1**, **1.0**, **10**} for **I** try {**0.001**, **0.01**}

This gives us a total of 18 possible combinations. For each combination I did qualitative evaluation of the car’s behavior. The best combination is highlighted in red.

P	I	D		P	I	D
0.1	0.001	0.1		1.0	0.01	0.1
0.1	0.001	1.0		1.0	0.01	1.0
0.1	0.001	10.0		1.0	0.01	10.0
0.1	0.01	0.1		10.0	0.001	0.1
0.1	0.01	1.0		10.0	0.001	1.0
0.1	0.01	10.0		10.0	0.001	10.0
1.0	0.001	0.1		10.0	0.01	0.1
1.0	0.001	1.0		10.0	0.01	1.0
1.0	0.001	10.0		10.0	0.01	10.0

Around this combination I refine the selection **P**={**0.1**, **0.3**}, **I**={**0.001**, **0.003**}, **D**={**1.0**,**3.0**}

This gives us 8 refined combinations. I keep the final combination after qualitative examination of the car’s behavior.

P	I	D
0.1	0.001	1.0
0.1	0.001	3.0
0.1	0.003	1.0
0.1	0.003	1.0
0.3	0.001	1.0

0.3	0.001	3.0
0.3	0.003	1.0
0.3	0.003	1.0

Effects P,I,D

- **P term:** The car steers opposite to the CTE error by CTE amount. The purpose is to keep the car close to the center lane. Most important side effect is an inevitable oscillation of the car relative to the center line (Line of CTE=0). When tuning this parameter a tradeoff needs be found. If set too high, the car will oscillate a lot with big amplitude. If set too low, the car will be slow to drive off the edges.
https://github.com/mmarouen/CarND-PID-Control/blob/master/videos/P_only.ogv
- **I term:** The cars steers opposite CTE sums up to that point in time. The purpose is to prevent “systematic bias” that is consistently driving on one side of the road. If used alone, the car tends to drive in circles. When used in combination with other parameters, we have a tradeoff to make. If too small, the car will drift on one side of the road over some period of time. If too big, the oscillations will be fast.
https://github.com/mmarouen/CarND-PID-Control/blob/master/videos/I_only.ogv
- **D term:** The car steers opposite CTE derivative. The purpose is to avoid oscillations around the center lane. Again, there’s a tradeoff to make when tuning this parameter. If set too high, the car will change direction with difficulty, this is especially bad when the car is moving away from the center lane. If too low, then we have overshooting and we cannot prevent oscillations around the center lane.
https://github.com/mmarouen/CarND-PID-Control/blob/master/videos/D_only.ogv

These parameters behaved as expected.

Improvement areas

1. Implement Twiddle algorithm for optimal parameters selection
2. Tune speed PID