Udacity Term2 – Self Driving Car Engineer

PID Controller

Basics of PID Controller:

Error: Difference between the process variable and the set point (desired value of the process variable)

P Term: This is the proportional term (also known as gain). This term is proportional to the error and determines how much the output will change based on the error term.

I Term: This is the integral or the reset term. This determines how much to change the output over time due to the error regardless of the direction of movement of the error.

D Term: This is the derivative term and determines how much to change the output due from a change in direction of the error or the process variable. This also is called a preact as it anticipates the sudden changes in the output and reacts quickly.

In my algorithm, these terms are denoted by the variables Kp, Ki and Kd. Also there are the terms Kp_, Ki_ and Kd_. These terms are a combination of PID terms and velocity dependent tuning parameters that vary the PID terms based on a set of alpha parameters. The I-term seemed to affect the most on the performance when the alpha parameters were tuned. Hence the PD alpha parameters are left 0.0.

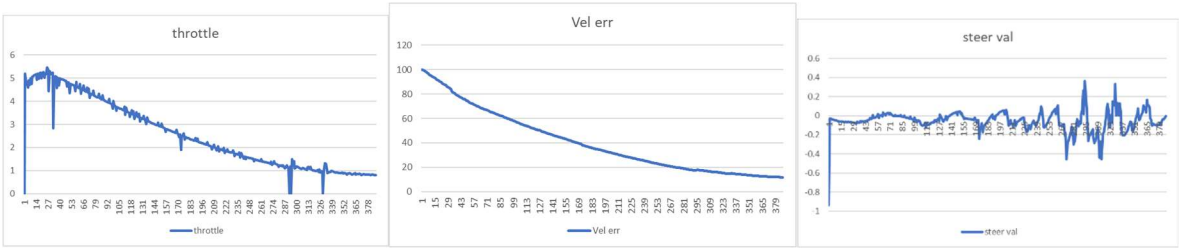
Tuning:

All parameters were tuned manually. I followed a well known sequence in order to arrive at a working set of parameters:

1. Make all PID terms 0. Then increase P term to a small level.
2. Double the P Term till oscillations begin.
3. When oscillations begin, halve the P-term.
4. Implement a small I-term and D-term
5. Increase D-term to react to sudden changes.

After doing tuning on a set throttle of 0.3, I was able to tune the lateral PID terms and alpha terms to enable a full smooth drive across the track.

Later, I implemented a PID controller for the throttle (longitudinal PID). This proved to be more difficult as there is an interaction of the lateral and longitudinal terms. Here I employed outputting data using fout and analyzing the behavior in excel charts. Example:



By analyzing behavior of each of the steering value and throttle, I was able to tune the PID terms for both the lateral and longitudinal controllers to enable the vehicle to go around the track.

For enabling emergency braking, I implemented a simple if condition where if the steering value goes beyond a limit, the brakes are applied (throttle negative).

Although the vehicle was able to go around the track, the performance is not smooth yet. Further tuning of the terms is necessary.

The trials of the tuning are recorded in the video here:

https://youtu.be/YZyFG7myWLA