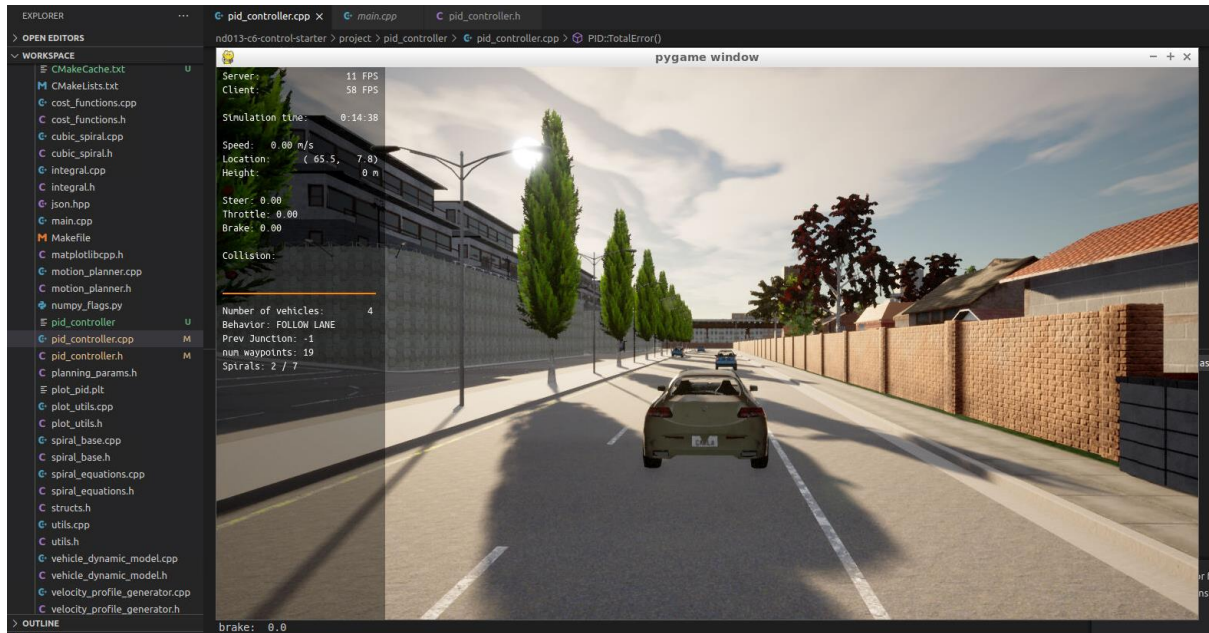# Control and Trajectory Tracking for Autonomous Vehicle

Step 1: Building the PID controller object

- Complete the TODO in the pid_controller.h and pid_controller.cpp.
- Running the simulator and see in the desktop mode the car in the CARLA simulator. The car is found not to move.

Step 2: PID controller for throttle:

- In main.cpp, completing the TODO (step 2) to compute the error for the throttle pid.

Step 3: PID controller for steer

Different parameters for tried for gain factors. Following all parameters lead to collision with wall.

	Kp	Kd	Ki	Maximum output	Minimum output
Throttle	0.5	0.0	0.0	1.0	-1.0
	0.5	0.001	0.0	1.0	-1.0
	0.21	0.0009	0.1	1.0	-1.0
	0.21	0.0006	0.08	1.0	-1.0
	2.0	0.8	0.1	1.0	-1.0
Steer	1.0	0.0	0.0	1.2	-1.2
	0.5	0.0	0.0	1.2	-1.2
	0.5	0.001	0.0	1.2	-1.2
	0.29	0.0011	0.3	1.2	-1.2
	0.3	0.0025	0.17	0.60	-0.60
	0.4	0.01	0.8	0.61	-0.61
	0.1	0.0	0.0125	0.61	-0.61
	0.3	0.01	0.4	1.2	-1.2

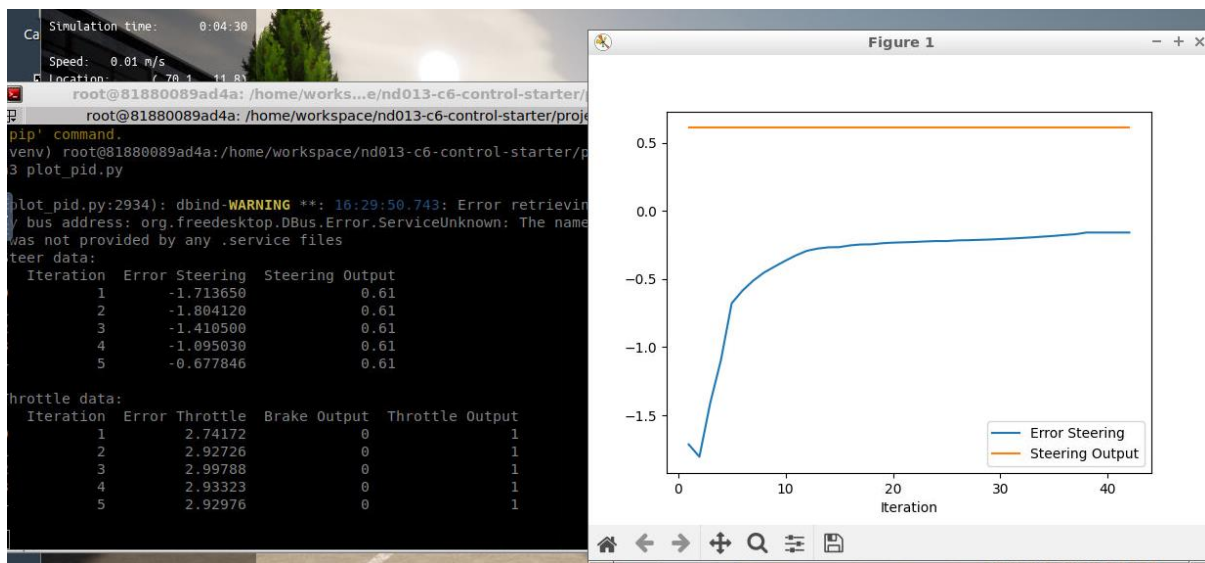|	0.3	0.0025	0.17	0.60	-0.60
	0.21	0.0006	0.08	1.0	-1.0

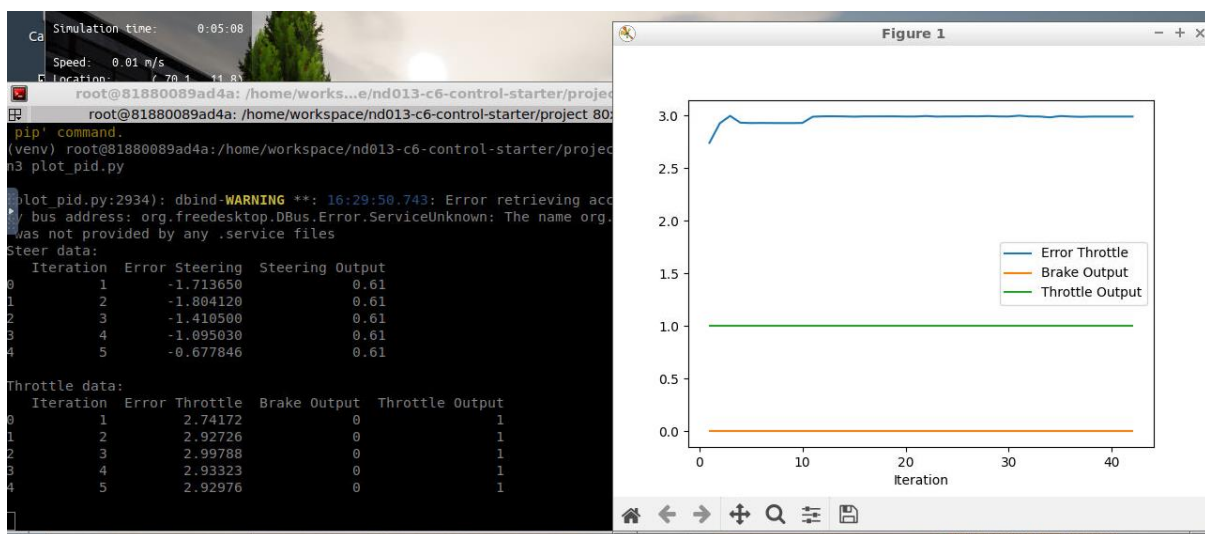Highlighted are the parameters used in this simulation for showing the results.

Step 4: Evaluating the PID efficiency

Q1. Add the plots to your report and explain them (describe what you see).
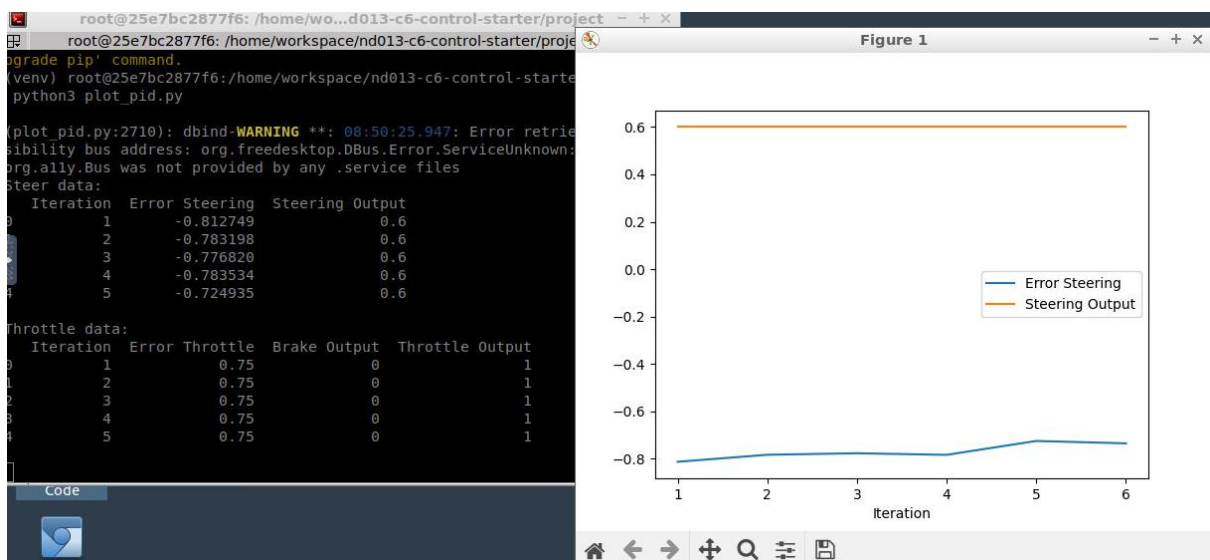
Implementation 1
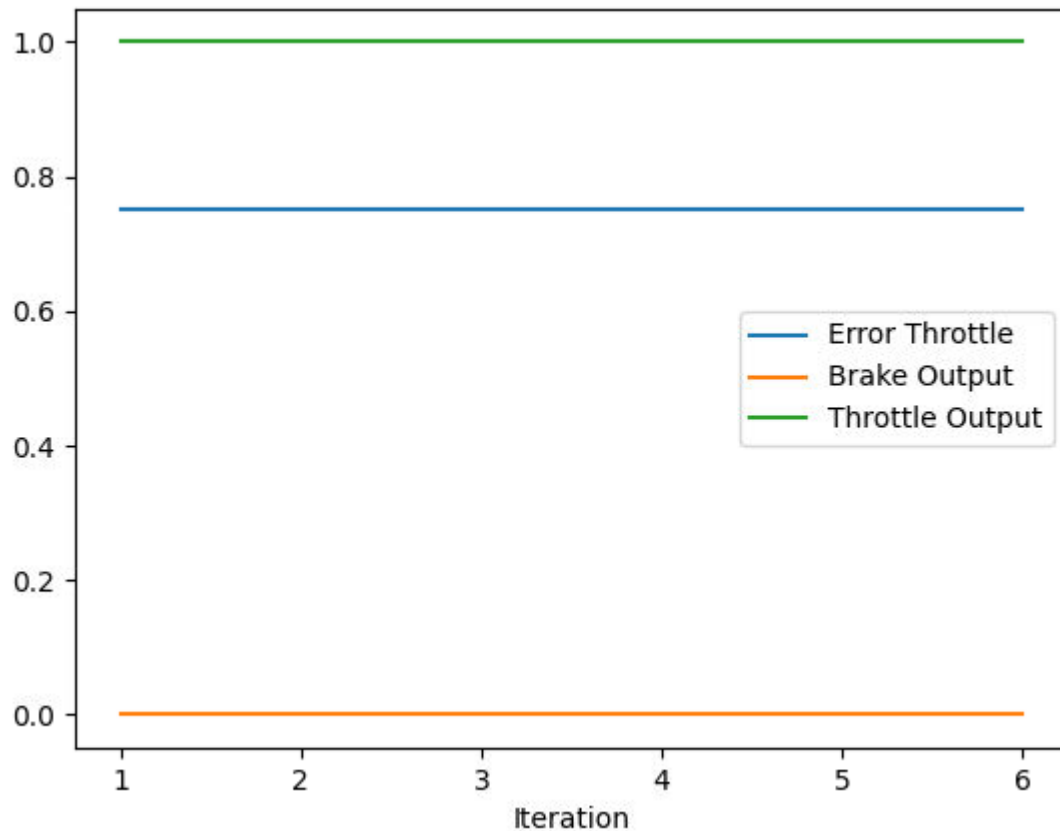

Error steering and steering output

Error throttle, brake output and throttle output

Implementation 2

Q2. What is the effect of the PID according to the plots? How does each part of the PID effect the control command?

- The values of proportional gain, if it is low lead to haphazard steering, if the values are high it will lead to overshoot and oscillations.
- This is one of the limitations of PID controller
-

Q3. How would you design a way to automatically tune the PID parameters?
- As discussed in the lesson, one of the ways is to use Twiddle algorithm.
-

Q4. PID controller is a model-free controller, i.e. it does not use a model of the car. Could you explain the pros and cons of this type of controller?

<u>Pros</u>:
a. It is widely used, tested and trial theory
b. It is easy to understand

<u>Cons</u>:
a. Parameter optimization/ tuning is more of hit and trial technique
b. This controller cannot deal with complex scenarios like sharp turns, turns in intersections etc.
c. There is limitation in handling high-dimensional nonlinear equations.