## Understanding for the PID Controller

P is the proportional part, the output of the P item is directly linked with the deviation between the control target and the control output, if the P parameter is too small, then the control output will slowly go to the control target, if the P parameter is too big, then the control output will quickly reach control target, and even lead to big overshoot.

I is the integral part, the output of the I item is the accumulated deviation with multiple with the I parameter. the I part is mainly used to solve the offset of the control deviation. But the I part will leads delay.

D is the differential part, the output of the D item is the deviation of the continues two control deviation with multiple to the D parameter. the D part like some kind of predict control, can be used to prevent the controller output, but too big D part will lead oscillation.

## Tuning for the PID parameter

The parameters for the PID project are tuned manually. It is tuned with the following step:

1. Tuned the P parameter first, to make the vehicle can drive itself in the lane in straight line and most of the small curves. During this stage, the vehicle control will be overshoot sometimes if the control deviation become big in some big curves.
2. The next step is too the add the D parameter, and with the D part, the vehicle behavior improved a lot, the vehicle can drives in the lane in all the situations and the oscillation is acceptable.
3. For the I parameter, I have see it can improve the control behavior in this project, it is mainly due to the vehicle model is balanced in left steer and right steer, no offset for the steer control, so I part is not needed in this project.