Wirte up: Project PID Controller Term 2 of SDCND

The code

Files worked on: main.cpp an PID.cpp

I followed the Q&A video which explains most of the code implementation. While most of it was just applying the lesson material to C++ I did take advantage of the re- architecting of the code to facilitate parameter fine tuning.
Lines 31 to 39 in main.ccp are doing that.
That way I can change the parameters when running the executable ./pid.
After fine tuning the parameters I ran the executable as follows:
./pid -0.1 -0.0001 -1.

In PID.cpp in Line 23 to 26 the function UpdateError takes care of the cross track error cte update. Key here is the trick to move d_error up and define it as cte-p_error, where p_error serves as a previous cte parameter.
I also implemented the TotalError function in line 29 to 31 of PID.cpp.

The parameters

Choosing the following values enables the car to drive a lap without errors:
Kp=-0.1
Ki=-0.0001
Kd=-1.

Fine tuning Kp, Ki and Kd.

Kp stands for proportional parameter, ie. proportional to the cross track error (cte)
Kp corrects the steering angle in proportion to the cte. Kp cannot have large absolute value, since then the car starts steering left and right with lots of wiggling. You need to keep Kp small so the car keeps a straight line and only reacts when the road curves.

Kd stand for differential parameter, ie. the parameter which fixes the steering angle as a function of the differential of the cte. as shown in lesson 17, section 5 around 0.52 Min.
Kd helps the car not wiggle too much. With a low Kd the car starts shaking around the track quickly and you get sick just watching it. Here is a screen shot of what happens when Kd is low:

The car drifts off the track quickly.
In order to prevent that Kd has to be high.

Ki accumulates all the cte and corrects accordingly. That's why Ki has to be small, otherwise the Ki term grows large very quickly and dominates the UpdateError function.

Further thoughts
I struggle understanding the function of Ki, since it is so small, what is the actual value of the parameter. Where does it come into play, what kind of scenarios do we need to see the true value of Ki. i am not clear about that. Further reading and more clarity in the lessons seems necessary.