Writeup

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1 Writeup

1.1 Project PID-Controller

1.1.1 Your code should compile.

To compile and run the code you should run following commands starting the base folder of this project:

```
mkdir build && cd build
cmake .. && make
./pid
```

1.1.2 The PID procedure follows what was taught in the lessons.

It's basically a standard PID controller including a saturation for the integrational error. This limits the i-error in order to avoid that the i-gain can't reduce it in time e.g. after leaving a curve, where it was neccessary to build up a high i-error to ensure not violating the track boundaries.

1.1.3 Describe the effect each of the P, I, D components had in your implementation.

The I-gain represents basically the not present knowledge of the track curvature, by integrating the error it learns mainly the neccessary steering angle to drive trough the corner. However, it is recommended to chose not that high I-gains as it probably will not converge to an appropriate steering angle, leading to jerky oder unstable behavior. As the disturbance, mainly the track curvature, varies by time it is on the other hand neccessary to swithc between different working points. This has to be done obviously with sufficient dynamics. In order to ensure that a left-right turn can be handled appropriatly, a saturation of the i-error is introduced to avoid that high i-errors, which can't be shifted to another working point in time. The P-gain is responsible for compensation of small sudden deviaitions of the path. However, a too large value leads to unstable behavior. Finally the D-gain introduces damping in the system and therefore stabilizes the system.

1.1.4 Describe how the final hyperparameters were chosen.

The hyperparameter are chosen somehow like ziegler-nichols method. However, some adaptions has to be made for the I-gain as no feedforwared is present. First the p-gain is increased until the vehicle oscialltes. Then the p-gain is reduced and a d-value is added until a smooth behavior

is present on straights. After that is reached a I-gain is implemented, which was choosen way higher as recommended by ziegler nichols as it has to provide almost the complete steering angles in curves. Finally the maximum i-error is chosen, so that the curves can be driven and the car does not osciallte to much, when leaving the curve.

1.1.5 The vehicle must successfully drive a lap around the track.

It does :)

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