Writeup for PID and Wall Following

CS 519 / ECE 599

Insuk Joh

Compute steer angle, based on D[t+1]

: What the steering angle does is that it determines the amount of error on next time interval.

It can be expressed by the next equation:

D[t+1] = Lookahead_distance x sin(alpha)

>> D[t+1] / Lookahead_distance = sin (alpha)

>> alpha = arcsin(D[t+1] / lookahead_distance)

Choice of lookahead distance L

: my choice was L = 0.075. This number was chosen, considering the velocity of car, the updating time interval, and computational delay. The velocity of the car is between 0.5 to 1.5, depending on the wheel angle. The fastest speed is considered here. Also, the data update rate is considered. It turned out that the data are updated on every 0.025 sec. The next factor considered is the computation delay. When tested with print(), not all data are updated with same speed. To prevent the racing condition, it uses 2 update time interval to stabilize the update time. In equation, this would be

L = 0.075 = 1.5 x 0.025 x 2

(max velocity) (update time) (safe update)

Tuning procedure for PID Gains

: The tuning is done by trial and error. First, only the proportional constant Kp is tested without Kd. Once the error converges to zero fast enough, then the differential constant Kd is added to reduce the overshoot.

Eqn (1) (Equation about the angle alpha)

: Eqn (1) shows how to solve angle alpha from Lidar data. For the wall on the right side, the following equation is used:

$$\alpha = tan^{-1}\left(\frac{a\cos(\theta) - b}{a\sin(\theta)}\right)$$

However, this equation is valid only for the wall on the right side. For the wall on left side, different equation should be used to compute the angle alpha properly. The equation I used is

$$\alpha = tan^{-1}\left(\frac{b - a\cos(180-\theta)}{a\sin(180-\theta)}\right)$$

The first equation is used if the wall is on the right side, and the second equation is used if the wall is on the left side.