Proportional-Integral-Derivative(PID) Controlled Car

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Lab Section 1A

Haoxuan Li, Chihchieh Fan

Develop

In developing the PID-controller, sensor values from the infrared sensor were combined in a process of sensor fusion and weighted in accordance to their significance in turning the car. Therefore, the proportional error arising from its current position on the track determined the kp value and subsequently, the kd value. During testing, the car's sensitivity to light frequently causes it to run out of the track, mostly a result of faulty minimum values generating exponentially massive and unreadable speeds. In order to remedy this problem, we decreased the minimum values accordingly until the sensors consistently gave significant values. Completing the track with a base speed, kp, and kd was a sign that the possibility of encoders could be used to further improve the efficiency of the car at different places on the track.

Conduct

During test runs, we aimed to maintain the methods to determine PID in which the weighted sensor values and previous sensor values would not change as well as the minimum and maximum constant sensor values. In order to determine the optimal speed per track shape, the only variables we changed per test run were the speed of the motors and the ratio of kp and kd. The PID-control operated on the basis of the car's infrared sensor measuring their current values and comparing it to our predetermined and constant minimum and maximum values.

Analyze

k_p	k_d	turning responsivity	error correction
0.045	0.27	3	3
0.045	0.27	3	3
0.05	0.3	4	4
0.05	0.3	4	4
0.055	0.33	5	4
0.055	0.33	5	4
0.055	0.33	5	4
0.055	0.33	5	4
0.06	0.36	5	5
0.06	0.36	5	5
0.06	0.36	5	5
0.06	0.36	5	5
0.07	0.42	5	4
0.07	0.42	5	3
0.095	0.54	5	2
0.1	0.6	4	2
0.1	0.7	4	2
0.12	0.72	4	1
0.13	0.78	3	1
0.14	0.84	3	1
0.15	0.9	2	1
0.16	0.96	2	1
0.17	1.02	1	1
0.18	1.08	1	1

Figure 1

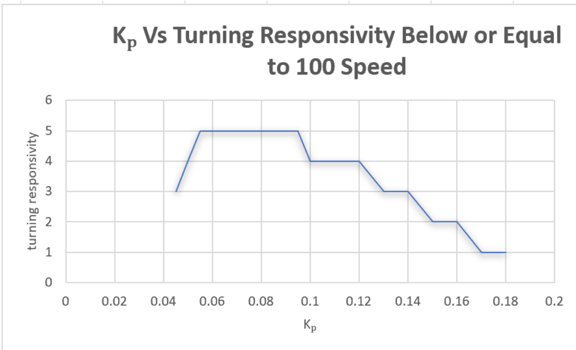


Figure 2

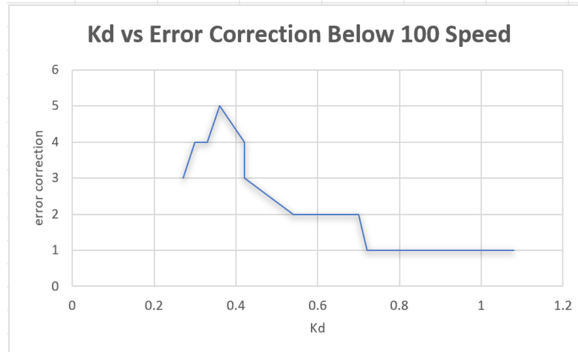


Figure 3

k_p	k_d	turning responsivity	error correction
0.055	0.33	2	4
0.07	0.42	2	3
0.075	0.45	2	3
0.1	0.6	3	3
0.12	0.72	3	2
0.15	0.9	4	2

Figure 4

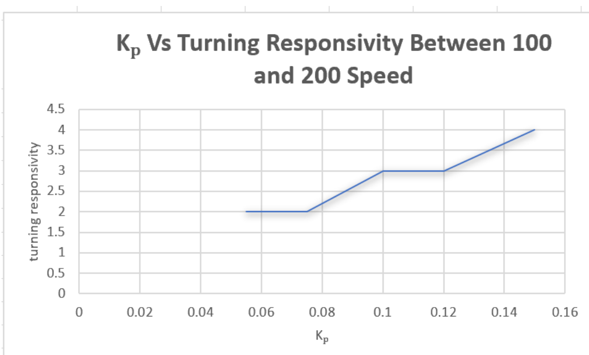


Figure 5

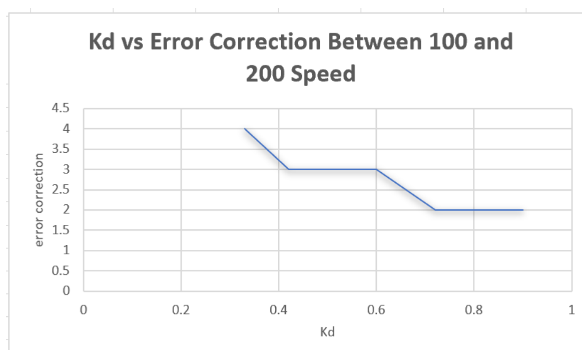
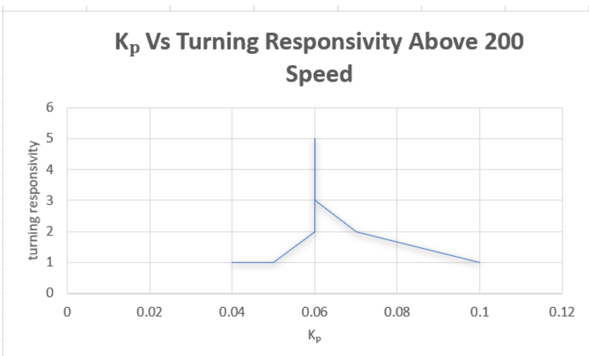


Figure 6

k_p	k_d	turning responsivity	error correction
0.04	0.24	1	4
0.05	0.3	1	4
0.05	0.55	1	5
0.06	0.6	2	5
0.06	0.6	5	4
0.06	0.6	3	2
0.07	0.95	2	2
0.1	0.6	1	2

Figure 7



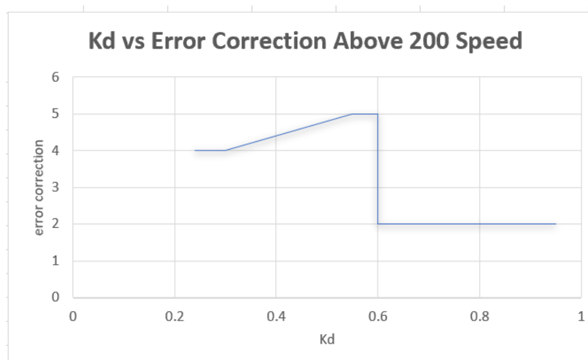


Figure 8

Figure 9

Haoxuan Li
Chih-Chien Fan

TEST LOG ENTRIES

Kp	Kd	starting position	speed	turning responsivity	error correction
0.045	0.27	1	70	3	3
0.045	0.27	2	90	3	3
0.05	0.3	1	100	4	4
0.05	0.3	2	100	4	4
0.055	0.33	1	120	5	4
0.055	0.33	2	97	5	4
0.055	0.33	3	97	5	4
0.055	0.33	4	97	5	4
0.06	0.36	1	100	5	5
0.06	0.36	2	100	5	5
0.06	0.36	3	100	5	5
0.06	0.36	4	100	5	5
0.07	0.42	1	100	5	4
0.07	0.42	2	100	5	3
0.095	0.54	1	90	5	2
0.1	0.6	1	100	4	2
0.1	0.7	2	100	4	2
0.12	0.72	1	100	4	1
0.13	0.78	1	100	3	1
0.14	0.84	1	100	3	1
0.15	0.9	1	100	2	1
0.16	0.96	1	100	2	1
0.17	1.02	1	100	1	1
0.18	1.08	1	100	1	1
0.055	0.33	2	100	2	4
0.07	0.42	1	100	2	3
0.075	0.45	1	120	2	3
0.1	0.6	1	120	3	3
0.12	0.72	1	100	3	2

Kp	Kd	starting position	speed	turning responsivity	error correction
0.15	0.9	1	100	4	2
0.04	0.24	1	200	1	4
0.05	0.3	1	200	1	4
0.05	0.55	2	200	1	5
0.06	0.6	1	200	2	5
0.06	0.6	2	200	5	4
0.06	0.6	3	200	3	2
0.07	0.95	1	240	2	2
0.1	0.6	1	200	1	4

Interpret

Figure 1 shows the kp and kd values when the car ran below or at one hundred speed and how it affected the turning responsiveness and error correction as a direct result of the changing ratio between kp and kd.

Figure 2 is a graph that represents how the kp values tend to output better results around a specific range and therefore develop a bell curve around those kp values.

Figure 3 represents how the kd performance seems to follow a linearly decreasing slope that corresponds to kp increasing in tandem.

Figure 4 shows the kp and kd values when the car ran above one hundred but below 200 speed; here errors could arise from the increased speed so it is important to account for the changing kp and kd values if desired.

Figure 5 has part of the bell curve that was visible in Figure 2 as the values tend to exhibit less significant change near the plateau.

Figure 6 shows the direct correlation between the pattern found in Figure 3 but at different kp and kd values at different speeds, asserting the fact that kd follows this general trend

Figure 7, similar to Figure 1 and Figure 4, show the kp and kd values for speeds beyond and equal to 200.

Figure 8 begins to show the volatility of responsiveness as speeds start to exceed the read times of the IR sensors and values become less consistent; although it still follows the general bell curve observed in previous Figure 5 and mostly Figure 2.

Figure 9, similar to Figure 8, shows a less desirable version of the original linear down curve shown in Figure 3.