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ECE3 21S Final Project Report

Develop

- My development plan first needed me to manually calibrate my sensor values so that when sensor fusion was needed from the RSLK car's phototransistors, I could have data that was normalized to an extent, without differing minimums and maximums per sensor.
- After this calibration, I implemented a proportional and derivative control by coding a rudimentary outline and structure of what my car would need to do on its track (I did not implement an integral control as I didn't see many benefits as opposed to the many complexities).
- After testing out my compiled code, I realized that there were some problems with it as it would not recognize that it needed to do a donut and that the finish line did not make the car stop (both errors regarding the code not determining a horizontal black line).
- Once fixing these errors, I knew it was okay to move on to the next step in my plan, which was continuously finetuning my Kp, Kd, and base speed variables to make it follow the path in a reasonable time and complete the objective of path following.
- For this step, I knew to keep tuning the Kp and Kd and test until I had reached a consistent path following at a specific base speed, and only then I knew it was okay to increase the base speed and tune again until I reached a completion time I was satisfied with (if I believed the speed was too high I decreased it to get a consistent test).

Conduct

- The variables that I was able to control were the ambient sunlight in my room (time of day), the battery voltage (switching out batteries when voltage too low), the track/starting position, my weighting scheme, the proportional constant, derivative constant, and base speed of my car.
- I measured the battery voltage, time for completion, min values per sensor (set on white paper at the start of each run), and effect on the car depending on the controlled Kp, Kd, track/starting position and base speed variables.
- For all of my different base speed cases, the first test that I ran was running the car, with my controlled variable Kp set, on a straight path to see how the car deals on just a straight line.
- After I got to a point, by adjusting Kp, which was smooth/oscillatory on a straight path, I moved it onto the actual race path and adjusted my Kd values depending on the effect on the car I saw and its ability to follow the path.
- I always started with position three and changed Kp and Kd until it completed the path, then went to test other starting positions, and once those were also completed, I increased my base speed and started my testing on the straight path again.
- In general, my testing scheme was repetition between different base speeds and manual sensor calibration and if I wasn't able to get it working for some base speed, I decreased it and repeated the process again.

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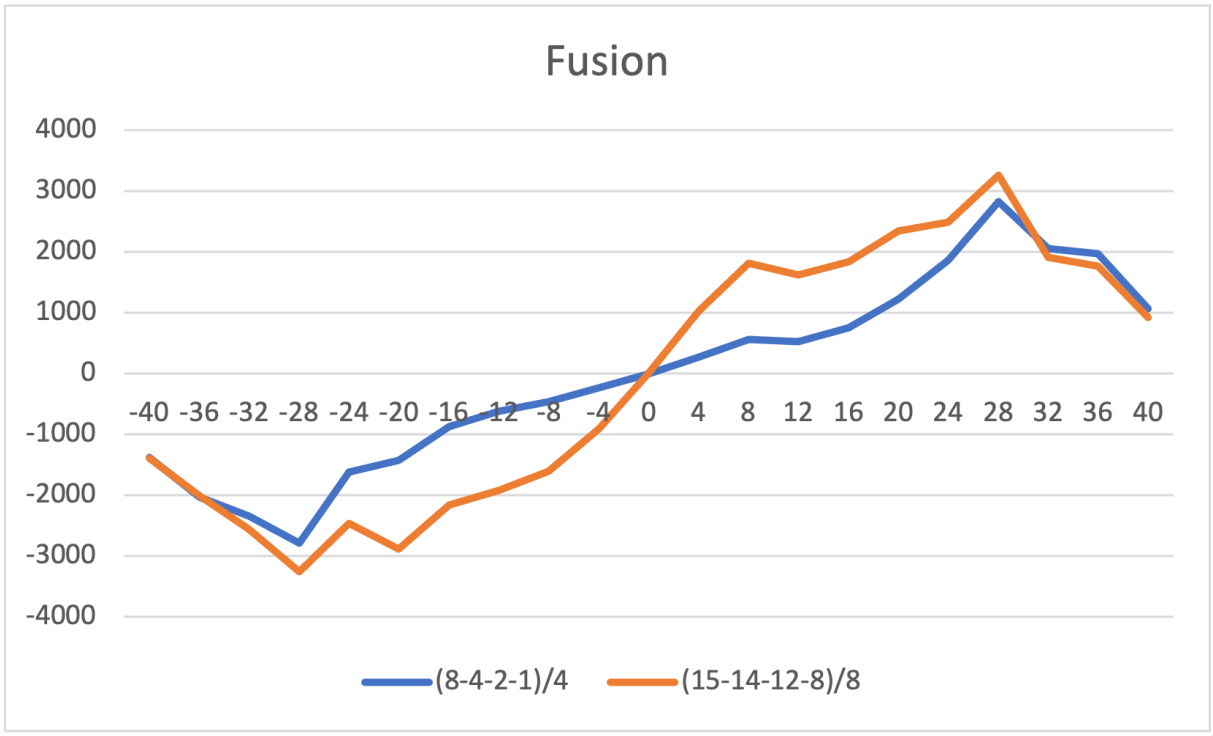
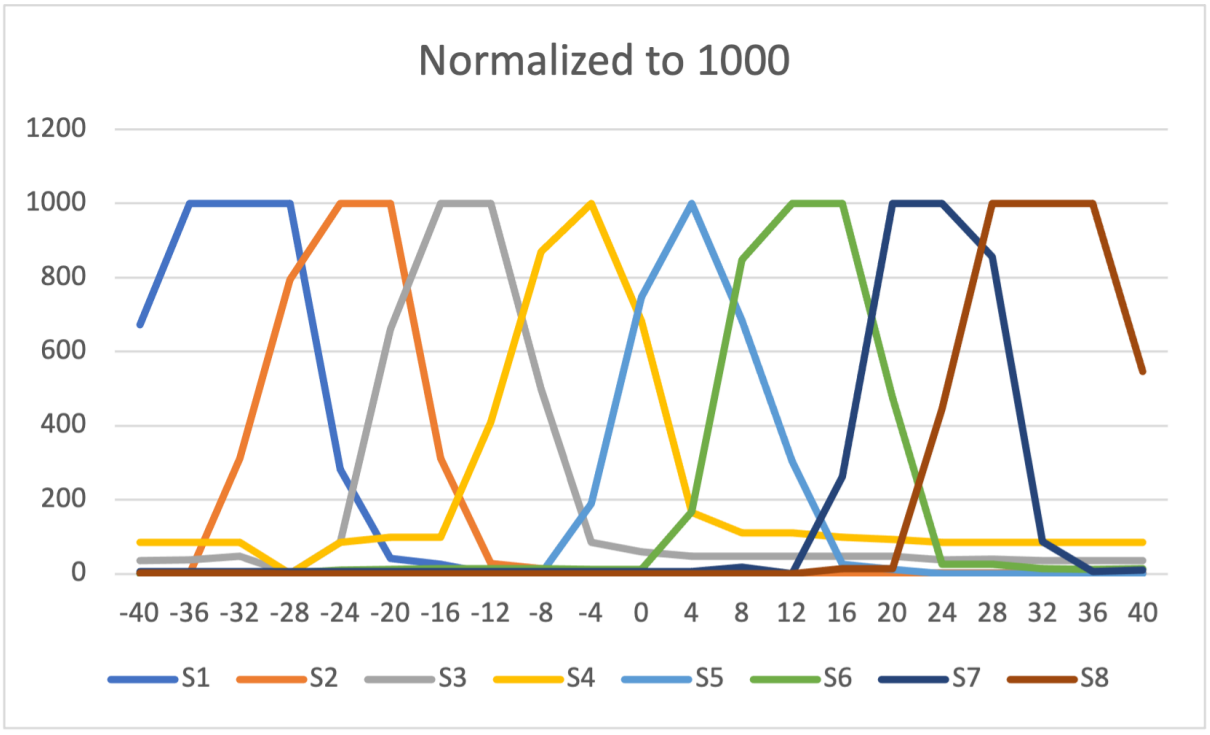
Analyze



Graph 1: RSLK Car Sensor Fusion with Weighting Schemes



Graph 2: Manual Sensor Calibration with Values Normalized to 1000

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Pass/Fail	Base Speed	Kp	Kd	Track/Position	Batt Voltage	Notes							
2	F	20	0.025	0	Straight	8.9	Donut didn't work							
3	F	20	0.025	0	Straight	8.9	Donut worked but didn't stop at finish line							
4	P	20	0.025	0	Straight	8.9	Both donut and finish line worked							
5	F	40	0.1	0	Straight	8.9	veered off track							
6	F	40	0.05	0	Straight		veered off track							
7	F	40	0.04	0	Straight		oscillated a little then veered off							
8	F	40	0.03	0	Straight		oscillated almost all the way then veered off							
9	P	40	0.035	0	Straight		oscillated very consistently							
10	P	40	0.035	0	Straight	8.9	oscillated very consistently							
11	F	40	0.035	0	3	8.85	immediately veered off track							
12	F	40	0.035	0.05	3		got on track for a little bit then veered off at first turn							
13	F	40	0.035	0.1	3		overcorrected itself too much							
14	F	40	0.035	0.15	3		again just doesn't want to make any turns							
15	F	40	0.04	0.1	3	8.85	keeps going back and forth and seems like theres no hope trying with 40 base speed, will decrease to 30							
16	F	30	0.04	0	Straight	8.9	went off track when tried to correct itself							
17	F	30	0.02	0	Straight		went off track a little bit but seems like its not correcting itself enough							
18	F	30	0.025	0	Straight		again, seems like we need a little more correcting							
19	P	30	0.035	0	Straight		stays on track with proper oscillations and looks great and smooth							
20	P	30	0.035	0	Straight	8.9	testing it more to make sure its ready to move to curved track							
21	F	30	0.035	0	3	8.9	as expected, doesn't work because it doesn't stabilize after correcting							
22	inconsistent	30	0.035	0.1	3		seems like it works most of the times just sometimes on the curves it is inconsistent with its stabilize							
23	P	30	0.035	0.05	3	8.9	works perfectly on position 3, time to move to diff position							
24	P - time:29s	30	0.035	0.05	1,2,4	8.7	works VERY consistently, time: 29 seconds, move to 40 base speed							
25	F	40	0.035	0.05	Straight	8.7	doesn't oscillate the way I want it to, kinda jerky							
26	F	40	0.04	0.05	Straight		checked to see if this will decrease jerk but it increased it							
27	F	40	0.03	0.05	Straight		this also increased jerk so back to .035							
28	inconsistent	40	0.035	0.05	Straight		works almost everytime now for some reason							
29	P	40	0.035	0.05	Straight	8.7	went to take a break and now it just works everytime							
30	F	40	0.035	0.05	3	8.8	as expected, doesn't work, corrects too much							
31	inconsistent	40	0.03	0.05	3		kind of works, doesn't work sometimes on the last curve when its coming back							
32	inconsistent	40	0.035	0.04	3		tried to switch up the variables a little to see if anything would happen, did the same thing as last test							
33	F	40	0.03	0.04	3		veered off immediately							
34	F	40	0.035	0.03	3		veered off at second curve on the way forward							
35	inconsistent	40	0.035	0.06	3		kind of works but screwed up after the donut							
36	inconsistent	40	0.03	0.06	3		works now but sometimes won't make the curve for the last curve and will just go straight							
37	P - time:23s	40	0.03	0.055	3	8.8	consistently and smoothly works for this speed and position, check on other positions							
38	inconsistent	40	0.03	0.055	1,2,4	8.8	works most of the time, just not always so im just going to move on to 50 base speed							
39	F	50	0.03	0.055	Straight	8.6	just veers off track without oscillating							
40	F	50	0.025	0.055	Straight		oscillates a little and goes out of control							
41	F	50	0.02	0.055	Straight		veers off immediately							
42	F	50	0.035	0.055	Straight		veers off immediately							
43	F	50	0.04	0.055	Straight	8.7	Kept not going straight or oscillating properly, so just going to stick with reliable 30 speed							

Table 1: Test Logs with Variables and Measured Effects on RSLK Car

Interpret

- Graph 1 was used to understand the effects that different weighting schemes had on my "error" value depending on how far away I was from the middle of the path, which helped me create my weighting scheme and a foundation for my Kp and Kd value.
- Graph 2 resulted from normalizing data so that outliers between specific sensors and irregularities between different IR Sensors were taken into account, and the process also helped me determine the baseline for my min/max values for fusion in my code.
- Table 1 kept track of my speed, Kp, and Kd tuning to find that having a smooth oscillation on a straight path before testing on a curved path was the fastest way to ensure success; I was able to deduct that having Kp set through a straight path and then tuning Kd and Kp (within a range) on the curvy path helped for more efficient results.