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ECE3 21F

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Develop

For my development plan, I first wanted my robot to correctly follow a straight line. To clear my plan's first step, I would need to ensure my normalization, weighted value, and adjustment speed equations work appropriately to estimate the K_p and K_d values that will allow the robot to at least follow a straight line. Next, I would repeatedly test for the most optimal K_p and K_d values for when my car turns. To clear this step, I will need to repeatedly test different K_p and K_d values and select the values that allow my project car to smoothly and accurately turn (while also increasing my car's speed as much as possible). The next step is to have the car spin 180° upon detecting the ending and starting blocks without spinning in the middle of the track. I will move on to the next step after I have confirmed that my car can complete the track two consecutive times. For the last step, I will need to set a counter that causes my robot to spin 180° at the ending block and stop at the starting block. To clear this step, I would need to make sure my project car completes the entire track and only stops when it returns to the starting block, accomplishing the project goal.

Conduct Tests

The parameters I controlled include the K_p and K_d values, the left and right motor base speeds, and the weighted value. The variables I measured are the adjustment speed, the minimum and maximum value arrays of each sensor, and the normalized sensor values in an array. For the first test, I fixed the left and right motor base speeds to 40 so I can test which weighted value formula to use and best the K_p and K_d values that will let my robot follow the straight line. For the next test, I made the car follow curved paths and adjusted the K_p and K_d values so that it stayed on the line more smoothly and accurately while increasing the base speeds as much as possible without significantly changing the K values. For the next test, I used the encoder count variable and an if statement to estimate the 180° spin and tested if it would do so only when it has detected values greater than 700 on all sensors. For the last test, I will set a boolean variable as my counter to see if it will only spin at the end block and stop when it returns to the starting block.

Analyze

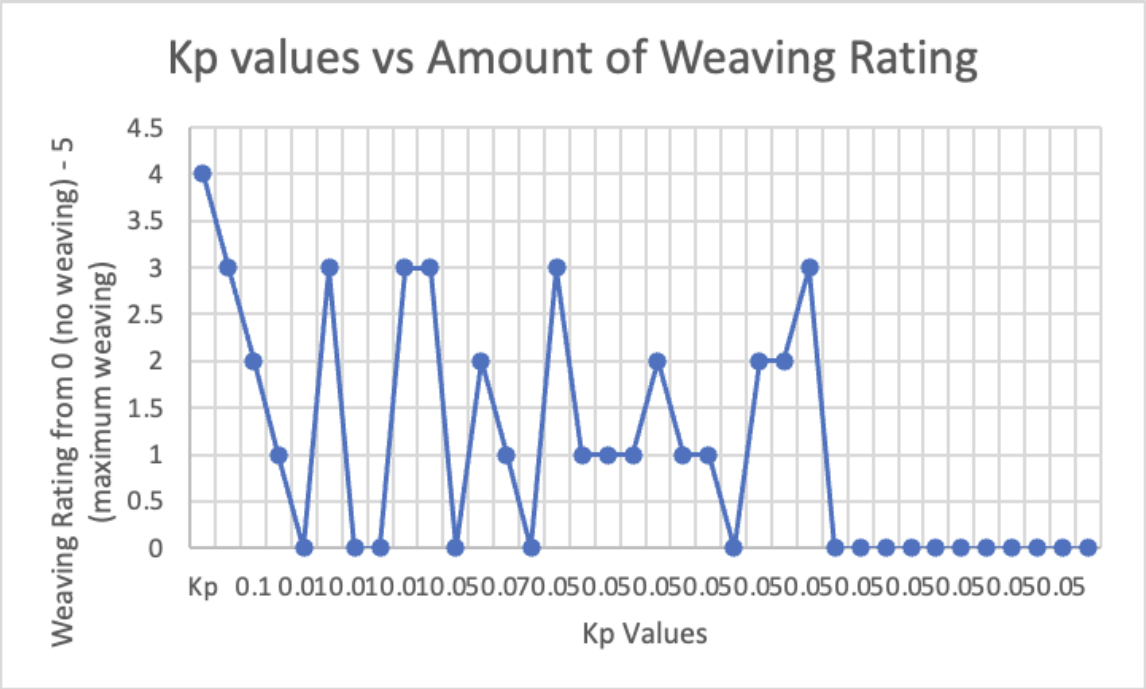


Figure 1. This is a graph of the K_p values (x-axis) and the amount of weaving ratings for all the recorded trials

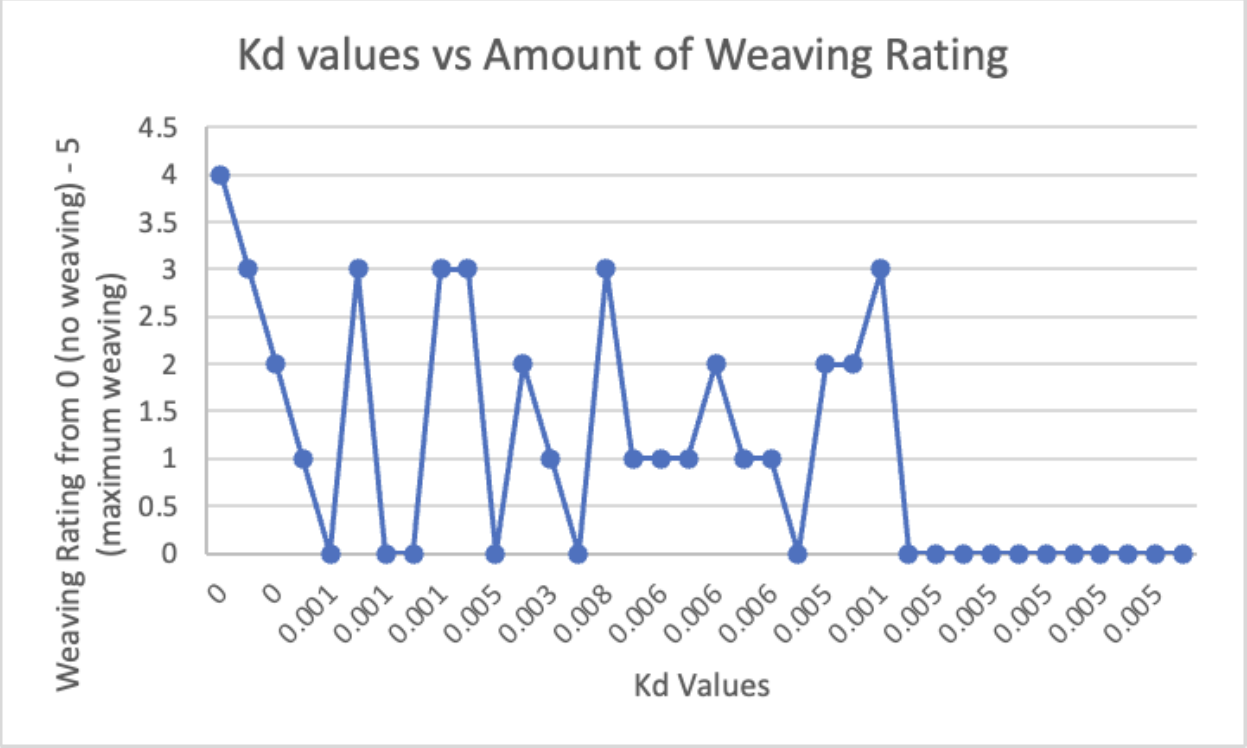
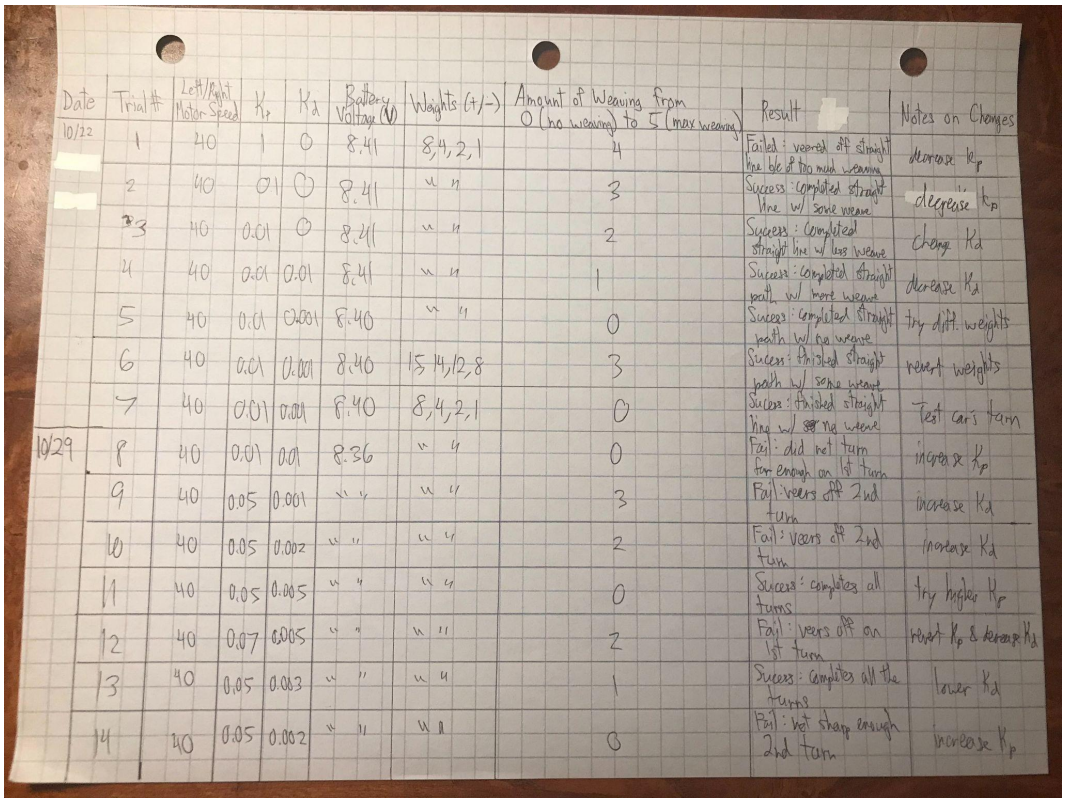
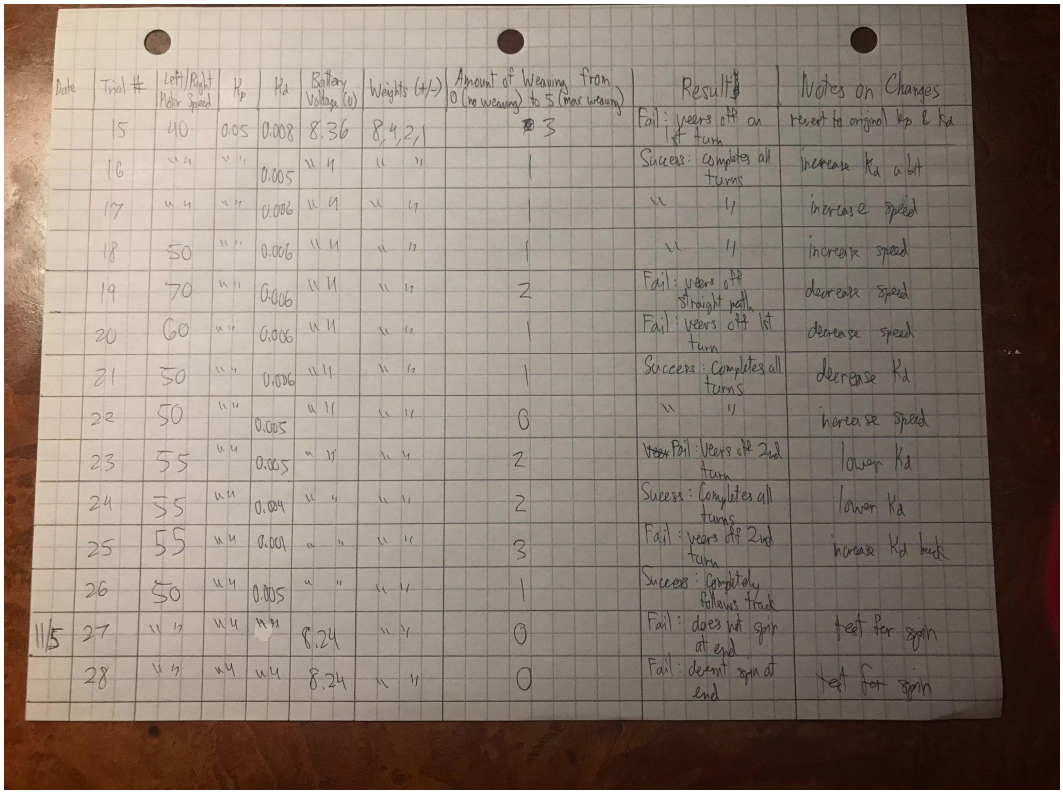


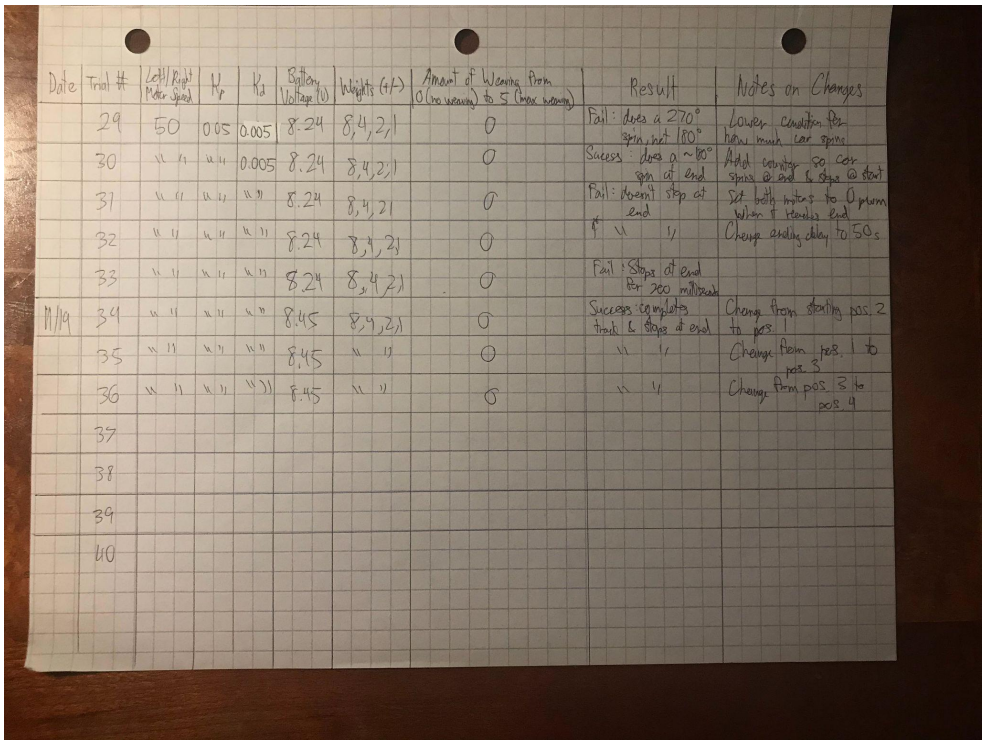
Figure 2. This is a graph of the K_d values (x-axis) and the amount of weaving ratings for all the recorded trials



Date	Trial #	Left/Right Motor Speed	K_p	K_d	Battery Voltage (V)	Weights (+/-)	Amount of Weaving from 0 (no weaving) to 5 (max weaving)	Result	Notes on Changes
10/22	1	40	1	0	8.41	8,4,2,1	4	Failed: veered off straight line bc of too much weaving	decrease K_p
	2	40	01	0	8.41	" "	3	Success: completed straight line w/ some weave	decrease K_p
	3	40	0.01	0	8.41	" "	2	Success: completed straight line w/ less weave	change K_d
	4	40	0.01	0.01	8.41	" "	1	Success: completed straight path w/ more weave	decrease K_d
	5	40	0.01	0.001	8.40	" "	0	Success: completed straight path w/ no weave	try diff. weights
	6	40	0.01	0.001	8.40	15,4,2,8	3	Success: finished straight path w/ some weave	revert weights
	7	40	0.01	0.001	8.40	8,4,2,1	0	Success: finished straight line w/ no weave	Test cars turn
10/29	8	40	0.01	001	8.36	" "	0	Fail: did not turn far enough on 1st turn	increase K_p
	9	40	0.05	0.001	" "	" "	3	Fail: veers off 2nd turn	increase K_d
	10	40	0.05	0.002	" "	" "	2	Fail: veers off 2nd turn	increase K_d
	11	40	0.05	0.005	" "	" "	0	Success: completes all turns	try higher K_p
	12	40	0.07	0.005	" "	" "	2	Fail: veers off on 1st turn	revert K_p & decrease K_d
	13	40	0.05	0.003	" "	" "	1	Success: completes all the turns	lower K_d
	14	40	0.05	0.002	" "	" "	0	Fail: not sharp enough 2nd turn	increase K_p



Date	Trial #	Left/Right Motor Speed	K_p	K_d	Battery Voltage (V)	Weights (+/-)	Amount of Weaving from 0 (no weaving) to 5 (max weaving)	Results	Notes on Changes
	15	40	0.05	0.008	8.36	8,4,2,1	3	Fail: veers off on 1st turn	revert to original K_p & K_d
	16	" "	" "	0.005	" "	" "	1	Success: completes all turns	increase K_d a bit
	17	" "	" "	0.006	" "	" "	1	" "	increase speed
	18	50	" "	0.006	" "	" "	1	" "	increase speed
	19	70	" "	0.006	" "	" "	2	Fail: veers off straight path	decrease speed
	20	60	" "	0.006	" "	" "	1	Fail: veers off 1st turn	decrease speed
	21	50	" "	0.006	" "	" "	1	Success: completes all turns	decrease K_d
	22	50	" "	0.005	" "	" "	0	" "	increase speed
	23	55	" "	0.005	" "	" "	2	Fail: veers off 2nd turn	lower K_d
	24	55	" "	0.004	" "	" "	2	Sucess: Completes all turns	lower K_d
	25	55	" "	0.001	" "	" "	3	Fail: veers off 2nd turn	increase K_d back
	26	50	" "	0.005	" "	" "	1	Success: Completely follows track	
11/5	27	" "	" "	" "	8.24	" "	0	Fail: does not spin at end	test for spin
	28	" "	" "	" "	8.24	" "	0	Fail: doesn't spin at end	test for spin



Date	Trial #	Left/Right Motor Speed	K_p	K_d	Battery Voltage (V)	Weights (+/-)	Amount of Weaving from 0 (no weaving) to 5 (max weaving)	Result	Notes on Changes
	29	50	0.05	0.005	8.24	8,4,2,1	0	Fail: does a 270° spin, not 180°	Lower condition for how much car spins
	30	" "	" "	0.005	8.24	8,4,2,1	0	Sucess: does a ~180° spin at end	Add counter so car spins @ end & stops @ start
	31	" "	" "	" "	8.24	8,4,2,1	0	Fail: doesn't stop at end	Set both motors to 0 pwm when it reaches end
	32	" "	" "	" "	8.24	8,4,2,1	0	" "	Change ending delay to 50s
	33	" "	" "	" "	8.24	8,4,2,1	0	Fail: Stops at end for 300 milliseconds	
11/19	34	" "	" "	" "	8.45	8,4,2,1	0	Success: completes track & stops at end	Change from starting pos. 2 to pos. 1
	35	" "	" "	" "	8.45	" "	0	" "	Change from pos. 1 to pos. 3
	36	" "	" "	" "	8.45	" "	0	" "	Change from pos. 3 to pos. 4
	37								
	38								
	39								
	40								

Interpret

For the graph displaying the relationship between K_p values and weaving ratings (Figure 1), the plotted points generally oscillate before settling to a rating of zero and a K_p value of 0.05 since adjustments made to my code through trial-and-error will eventually decrease the closer I am to accomplishing the project goal. Likewise, Figure 2 shows the early errors (through the high weaving ratings) I encountered with my car that eventually approached 0 and the K_d value 0.005.