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Progress Report Week 9
3/31/17

Week 9

Situation

The objective of Performance Test 2 (Labs 09A/B/C) was to develop two different codes that could successfully complete the full track layout and meet the requirements from the Mission Concept Review. The AEV design that was determined to be the most efficient in Performance Test 1 was constructed and utilized for this lab. The assembled AEV was first programmed with a code that allowed the motors to reverse and be subject to a short yet large power surge whenever the AEV approached the gate or the R2D2 unit. This large power surge ensured that the AEV would consistently and quickly come to a stop at the appropriate places on the track. After a few runs were completed for testing this code, a design analysis tool in MATLAB was utilized for extracting and analyzing the data that the arduino collected. Next, a second code was similarly tested. This code allowed the AEV to coast to a stop (as opposed to generating a large power surge) whenever it approached the gate and the R2D2 unit. This code was uploaded to the AEV and tested. Then, the design analysis tool was used again in order to extract and analyze the data that the arduino collected during a test run for this second code.

The team analyzed the results from the test runs for both codes in order to determine which code was ultimately better for achieving the mission objectives. Because the Mission Concept Review specifically demands the AEV to be energy efficient, the team primarily analyzed how much power was being used in the different phases of the runs for each code. Another factor that the team took into account when comparing the effectiveness of the two codes was consistency.

Results and Analysis

The main focus of this lab was to determine which of the two prepared codes was most energy efficient. The most efficient design, one with a parallel body rather than vertical, had been previously determined in Performance Test 1. These results were taken and implemented into the testing performed in Performance Test 2. The first code used a power surge in the reverse direction to stop the AEV at all points when it was required to stop, including the gate, picking up the R2D2, and at the end of the run. After running the full circuit, data collected from this run was used to determine this code utilized 442.548 J of energy, as seen in Figure 1 of the appendix. The second code did not use a surge of power to stop the AEV, instead it allowed the AEV to coast to a stop at each of the stopping points of the circuit. This code had only been developed to run half of the track, but used just 102.262 J of energy for the half circuit it did run, as seen in Figure 3 of the appendix.

Since the coasting code only completed a half circuit, to compare the energy values, the power surge energy usage was divided by two, ending up with 221.274 J, to allow for a more accurate comparison. The power surge code was found to use over double the energy as the coastin code did for the half run completed. This dramatic difference in energy consumption was due to a couple different reasons. First, allowing the AEV to coast up to the stopping points means the power was cut, meanwhile the power surge code was still running the motors up until each stopping point. Also, to stop the AEV required a reverse of the motors and an extreme spike of energy to bring the vehicle to a complete stop. By eliminating this huge use of energy from the code and allowing the AEV to stop from the force of friction, this decreases the total energy consumed dramatically. A visual comparison of the differences in energy consumption can be seen in Figure 2 of the appendix. Based on these results, it was decided team should begin to focus on developing the coasting code because it was much more energy efficient than the power surge code.

One source of error in this test was how the two codes were compared. Since the coasting code was only able to complete half of the circuit, the total energy of the power surge was just divide by two so the codes could be compared. In actuality, both codes use more energy on the second half of the circuit due to the added weight of the R2D2 unit, so dividing the total energy by two is not a good representation of the energy used on the first half of the circuit. Another error in this lab was the AEV during the power surge code not making it all the way to the end of the track. The AEV stopped slightly before completing the circuit due to the increased mass with not enough motor power to propel it forward. This many have caused the final energy read out to be slightly higher than the actual energy consumed due to the time it took for the team to reach the AEV to stop the run.

Code 1 featured power surges before stopping points along the track to stop the AEV quickly, while code 2 allowed the AEV to gradually come to a stop. Because of the power surge in Code 1, the AEV came to a stop much more quickly than in code 2. For this reason, the AEV completed the track more quickly using code 1 than code 2. It was difficult to calculate the distance the AEV would drift using code 2, leaving the team to have to guess-and-check distances along the track. With code 1, it was easier to predict where the power surge should be implemented to stop at the desired location because the AEV stopped so quickly after. Code 2 left the stopping point of the AEV more up to chance than code 1 because drifting along the track is less controlled. Despite its unpredictable downsides, code 2 was more energy efficient than code 1. The power surge in code 1 required more energy than code 2 without the power surge. Comparing the energy used for half of the track, code 1 used 221 J of energy and code 2 used approximately half of that with 102 J of energy. Due to its much lower energy usage, code 2 will be expanded upon and pursued further. The team will have to better predict the distance the AEV will travel once the motors are cut and the drifting begins.

The team plans to complete one full circuit as stated in the MCR by using the provided track measurements, Figure 4 of the appendix, to calculate the total distance the AEV must travel to each of the stopping points. After calculating the expected distances, the team will check the numbers by running the AEV and adjusting the values as needed until the AEV stops in the desired position. All values of marks and times can been seen in Table 2 or the Arduino Code in the appendix. From the starting point to the gate, it was calculated to be 21.28ft, which translated to about 524 marks. The team assumes this value will be lower because it is calculated from the start to the gate and the AEV must stop before the gate. The AEV will then wait 7 seconds for the gate to lower until it continues on. For the next section of the track, while the AEV does start behind the halfway point, the R2D2 unit takes up some of the track space, so the team anticipates these two values to about cancel out and the distance be close to the 524 calculated marks. The AEV will wait 5 seconds before heading back with the R2D2 unit. From the pickup point to the gate, the team believes this distance will be lower than 524 marks to account for stopping before the gate and the length the R2D2 unit takes up on the track. At the gate , the AEV will wait another 7 seconds to let the gate drop before continuing. The last stretch of track from the gate to the end, the team anticipates the marks being greater than the calculated halfway point because the AEV is starting from behind the gate instead of right at it.

In the upcoming lab, the code will be finalized to ensure that the AEV completes all necessary portions of the MCR. The code that is the most complete at this time was the code that utilized the power surge of energy to stop the AEV. The team will work to further develop this code since it is near completion and only a few minor adjustments need to be made. Additionally, the team will work to further develop the code that utilizes coasting to a stop rather than reversing the motors. This code proved to be far more energy efficient as it only used 102.26 J of energy for half the track whereas the first code used about 220 J of energy for half of the track. In order to pursue energy efficiency, the team will work to develop this second code more since it has already proved to be far more energy efficient even though a full run was not completed.

The second code cuts the motor power to the AEV at about 230 marks and allows the AEV to coast to the first gate. Because the motors were cut at an earlier position than in the first code, the energy consumption was drastically reduced. The highest percentage of energy consumption was used during the portion of the code that had the AEV travel at a constant speed between the gates. By reducing this amount of time, the energy consumption was drastically reduced. In addition to completing this code, the team will further analyze the AEV design to ensure it is as efficient as possible. This may pose some issues however, as if the AEV is too drastically altered the positions will have to be altered as well. Additionally, if the weight changes too much with any modifications, the speeds will have to be adjusted accordingly.

<u>Takeaways</u>

This Performance Test 2 reinforced lessons from previous labs of how to develop a code with numerous function calls, upload a code to an AEV, and extract data that was collected by the arduino during a test run. The team was reminded of how to use the design analysis tool in MATLAB in order to plot the extracted data, how to divide such a plot into various phases, and how to analyze the plot to determine how efficiently the AEV utilized the supplied power. In this lab, the team learned how to compare the energy efficiency of two different codes in order to determine which code would ultimately be better for achieving the objectives of the Mission Concept Review.

<u>Upcoming Situation</u>

In the upcoming lab the team will focus on finalizing the nearly completed arduino code. This code successfully completes ¾ of the track currently, and with a little more troubleshooting will be able to complete all portions of the MCR. While completing the code will be the team's main priority, the team will also work on making the AEV more energy efficient by further developing the second code that was tested in this lab. Data will be collected as both codes are further developed to analyze how the energy is consumed and how improvements can be made. Finally, the team will make any necessary modifications to the design of the AEV to ensure maximum energy efficiency.

This week, the team will complete the progress report for lab 9, update the team website and work on the arduino codes in preparation for lab 10C on Monday, March 3rd. The progress report will be completed by Sunday, March 4th to ensure all portions are complete and submitted on time. There are no anticipated issues with the project deliverables for the upcoming week.

Appendix

Table 1: Projected Team Schedule

✓	Write Code for Testing	11 days	Thu 3/9/17	Thu 3/23/17	100%		1 hour		
✓	3D Printed Part Design	3 days	Wed 3/8/17	Fri 3/10/17	100%		1 hour		
✓	AEV Design 1 Build	11 days	Thu 3/9/17	Thu 3/23/17	100%	30 minutes	30 minutes		
✓	AEV Design 1 Test	1 day	Thu 3/23/17	Thu 3/23/17	100%	30 minutes	30 minutes	30 minutes	30 minutes
✓	AEV Design 2 Build	11 days	Thu 3/9/17	Thu 3/23/17	100%	15 minutes			
✓	AEV Design 2 Test	11 days	Thu 3/23/17	Thu 4/6/17	100%	30 minutes	30 minutes	30 minutes	30 minutes
✓	Write Code 1 for Testing	11 days	Thu 3/9/17	Thu 3/23/17	100%		30 minutes		
	AEV Final Design Completion	11 days	Thu 3/9/17	Thu 3/23/17	75%	15 minutes	15 minutes	15 minutes	15 minutes
✓	PDR	17 days	Sat 3/4/17	Mon 3/27/17	100%	1 hour	1 hour	1 hour	1 hour
✓	Write Code 2 for Testing	11 days	Thu 3/9/17	Thu 3/23/17	100%		30 minutes		
	Test Code 1 and 2	1 day	Thu 3/23/17	Thu 3/23/17	75%	45 minutes	45 minutes	45 minutes	45
	Progress Report Lab 10	3 days	Thu 3/23/17	Mon 3/27/17	10%		30 minutes		
	Performance Test 3 (test smaller portions of chosen code on chosen design)	1 day	Thu 3/30/17	Thu 3/30/17	0%				
	Progress Report Lab 11	3 days	Thu 3/30/17	Mon 4/3/17	0%				
	Final Testing	1 day	Thu 4/6/17	Thu 4/6/17	0%				
	Update Website	21 days	Thu 3/9/17	Thu 4/6/17	0%				
	Team Meeting Notes	21 days	Thu 3/9/17	Thu 4/6/17	0%				
	Critical Design Review Report	6 days	Thu 4/6/17	Thu 4/13/17	0%				
	CDR Oral Presentation	11 days	Thu 4/6/17	Thu 4/20/17	0%				

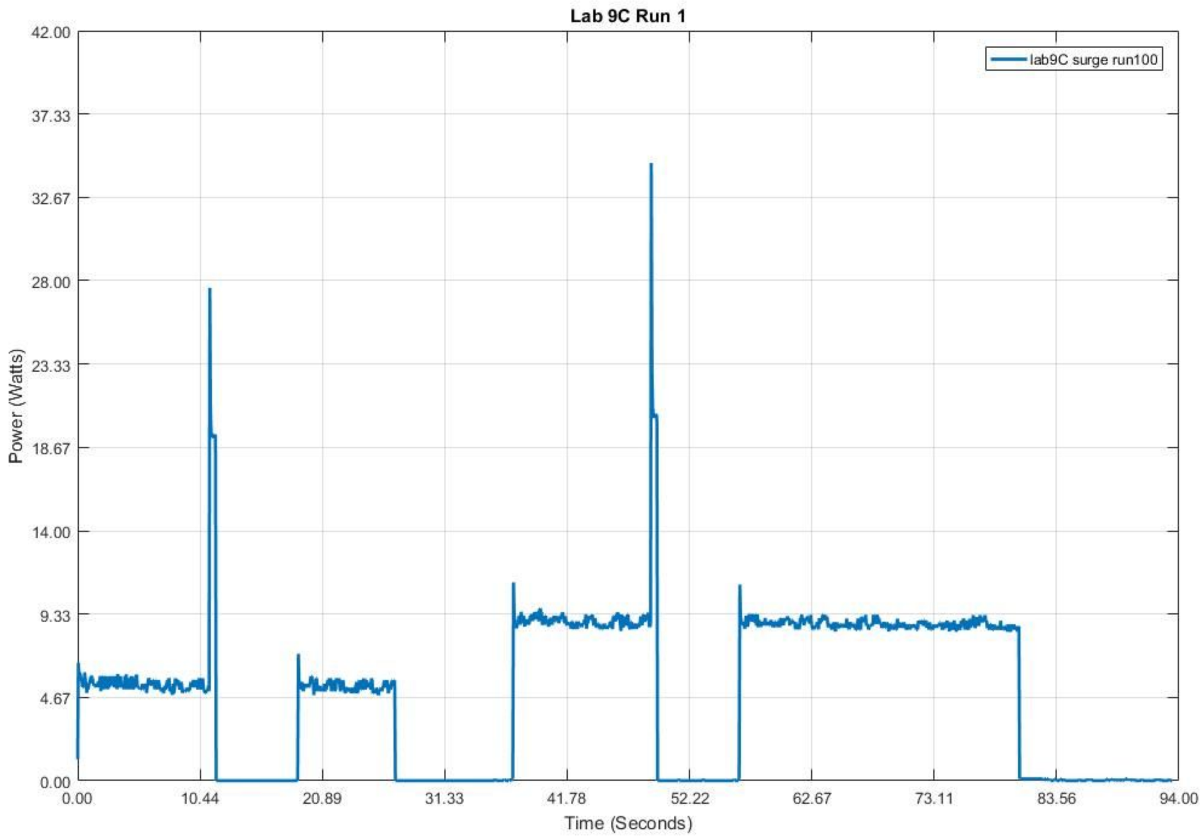

Figure 1: Lab 9C Run 1 Power Surge Arduino Code

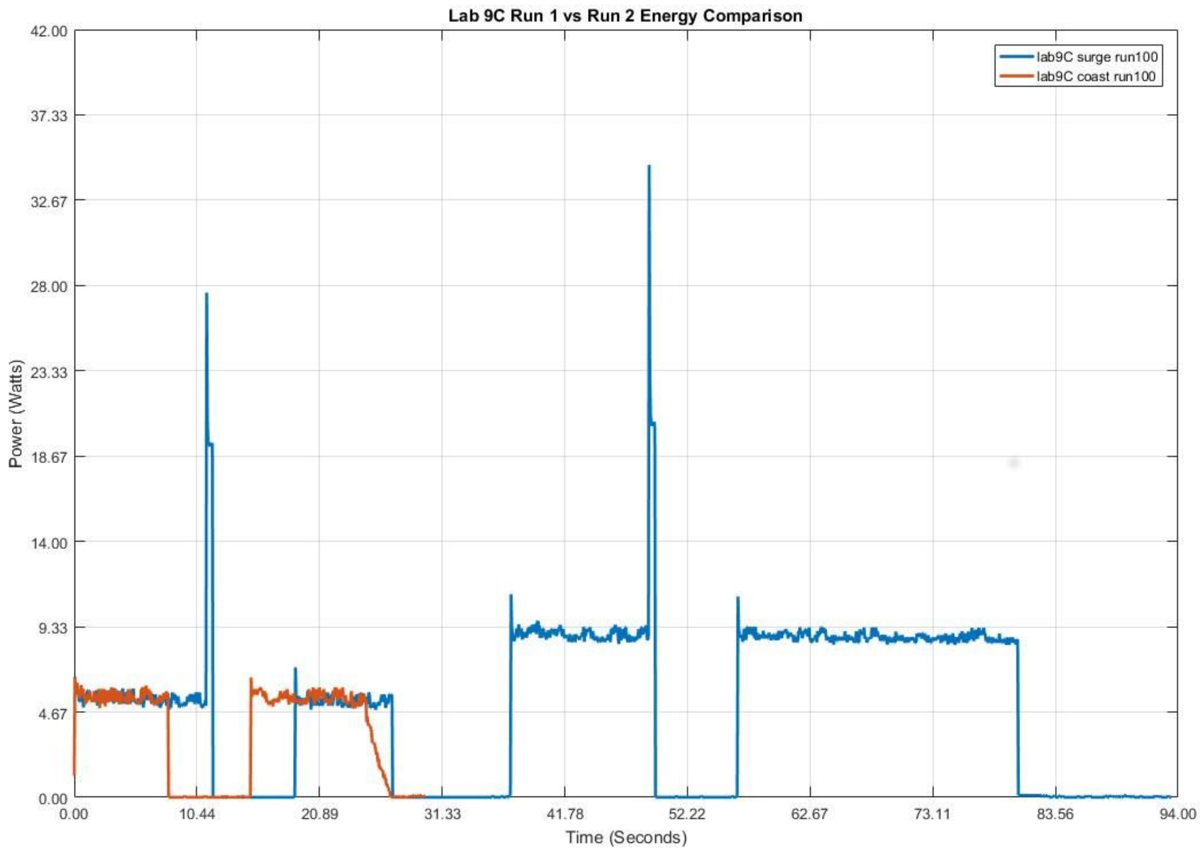

Figure 2: Lab 9C Run 2 Coasting vs Power Surge Arduino Code

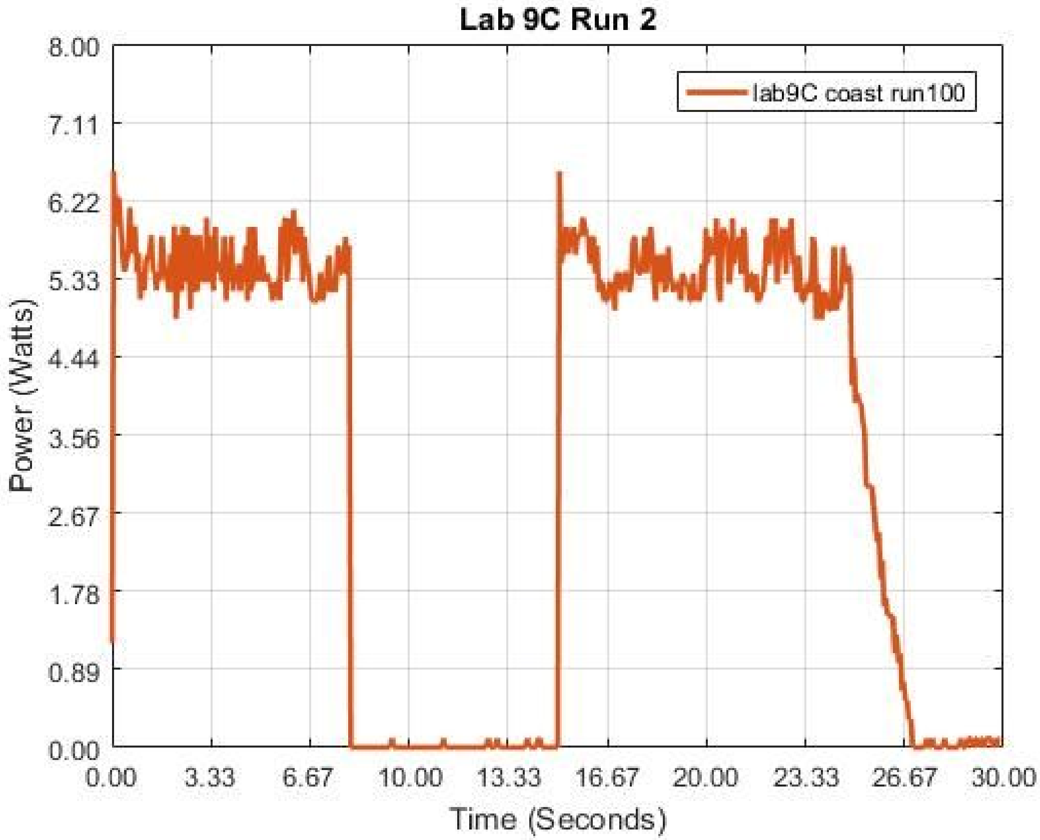

Figure 3: Lab 9C Run 2 Coasting Arduino Code

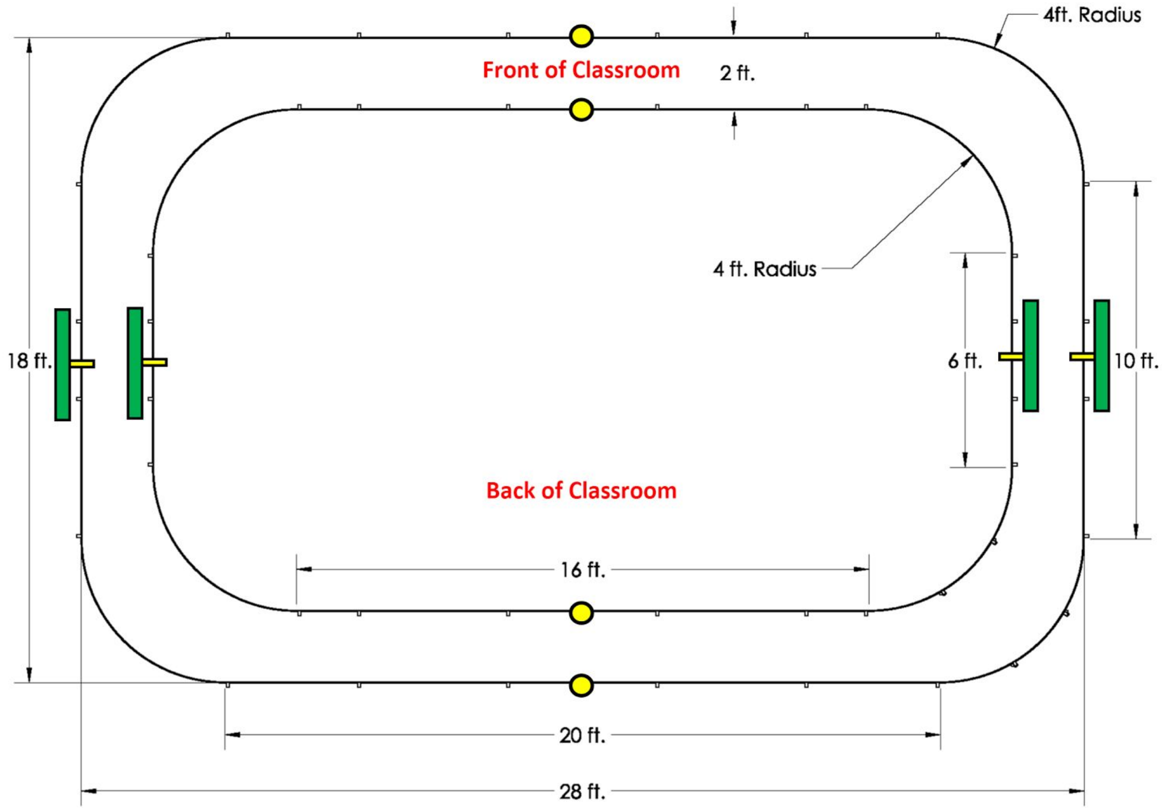

Figure 4: AEV Track Layout

Table 2: Distances and Times of AEV Run

Section of the Track	Distance Travelled (marks)	Wait Time (sec)
Start to Gate	<524	-
Gate	-	7
Gate to R2D2	~524	-
R2D2	-	5
R2D2 to Gate	<524	-
Gate	-	7
Gate to End	>524	-

Arduino Codes

Code 1:

```
//Positions are for upstairs track
//First quarter
```

```
reverse(4);
motorSpeed(4,22);
goToRelativePosition(463);
reverse(4);
motorSpeed(4,71);
goFor(.5);
brake(4);
goFor(7); //stop at gate for 7 seconds

//2nd quarter
reverse(4);
motorSpeed(4,22);
goToRelativePosition(318);
brake(4);
goFor(5);
goFor(5);

//3rd quarter
//start back with r2 unit
reverse(4);
motorSpeed(4,35);
goToRelativePosition(-415);differently
reverse(4);
motorSpeed(4,71);
goFor(.5);
brake(4);
goFor(7); //brake at gate for 7 seconds

//4th quarter
reverse(4);
motorSpeed(4,35);
goToRelativePosition(-310);
brake(4);
goFor(5);
goFor(5);
```

Code 2

```
//Positions are for upstairs track
//First quarter
reverse(4);
motorSpeed(4,22);
goToRelativePosition(230);
brake(4);
goFor(7); //stop at gate for 7 seconds

//2nd quarter
motorSpeed(4,22);
goToRelativePosition(318);
```

celerate(4,20,0,2); //or just do brake(4)

Team Meeting Notes

Date: 31-Mar-2017
Time: 12:06pm (Face-to-Face)
Members Present: Melanie Gross, Jennifer Bertrand, Katie Gonsoulin, Jessica Hudak
Topics Discussed: Lab 9 Progress Report

Objective: Today's goal was to assign parts for progress report, update the project portfolio website, and update the team calendar.

To do/Action Items:
-Progress Report: (JH, JB, MG, KG)
-Project Portfolio: (MG, JB, KG, JH)
-Team Calendar: (MG)

Decisions:
-Decide which code to continue developing (coasting to a stop or high powered reverse)

Reflections:
-Servo design would take too much time we don't have to develop it
-Best for the team would be to switch back to developing old design