Progress Report 1

Engineering 1182 Group O   Dr. Bixler
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Looking Back

Multiple exercises were completed in the past week to introduce basic programming, test motors, propellers, and sensors. In order to successfully code the AEV, the team needed to understand how the AEV operates. To do this, the team tested the vehicle on the track to get a visual representation of its performance. These tests were conducted as to observe the responsiveness and sensitivity of the vehicle. Once the team became familiar with the mechanisms, the vehicle needed to be designed for maximum efficiency and effectiveness. The team analyzed data, practiced creative design, and exercised concept screening and scoring. Each member conducted research and subsequently created a sketch of what they believed to be the best design for the vehicle. These designs were examined and tested on the track to determine the model that would best accomplish the goals of the project. With the observations and data collected from these tests, the team acquainted themselves with the AEV and discovered the best ways to code and design the vehicle.

Results and Analysis

As the programming basics exercises were conducted, the performance of the electric motors were monitored. The electric motors executed exactly what the code commanded and responded immediately, which was an important takeaway as the code was further created. The motors also switched direction and changed speeds as the code instructed. This impacted the AEV because the responsiveness and sensitivity is an important aspect of the design review, considering that this vehicle will be used as a transportation device. The brake command, however, did not stop the motors and propellers immediately. The motors stopped powering the propellers and they gradually spun to a stop. The reflectance sensors exercise displayed how the brake command combined with sensor input could produce smooth braking for the AEV, as opposed to harsh braking. The coasting technique for braking provides smooth transportation, however this method also increases total travel time which could also pose an issue depending on the requirements of the transportation.

Using the knowledge from these exercises, the materials given, weight, efficiency, and budget, creative designs for the AEV were constructed and the design is shown below. Half of the designs focused on weight and efficiency. The other half of the designs focused on balance, aerodynamics, and budget. The individual ideas were combined to create a team AEV design that focused on balance, budget, and efficiency. The four initial design concepts are shown below.

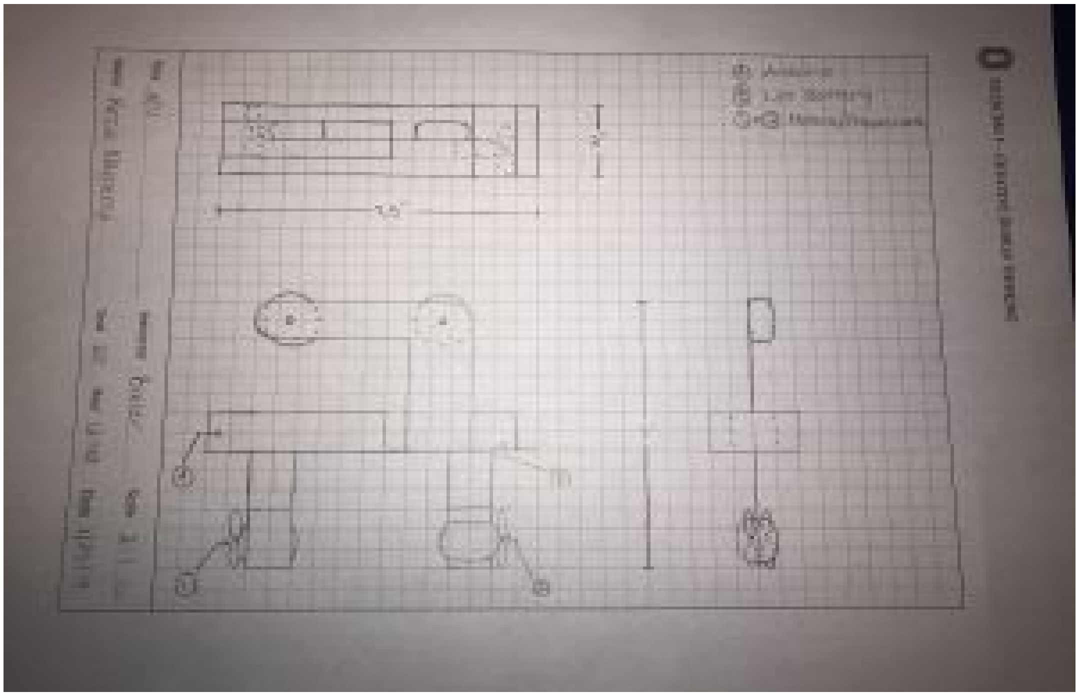

Figure 1: AEV designed by Kezia Namenyi

The figure 1 focuses on even weight distribution and unobstructed paths for the motored propellers. The arduino command center is two inches away from the lipo-battery and away from any metal. Its estimated weight is 290g and the estimated cost is 136$.

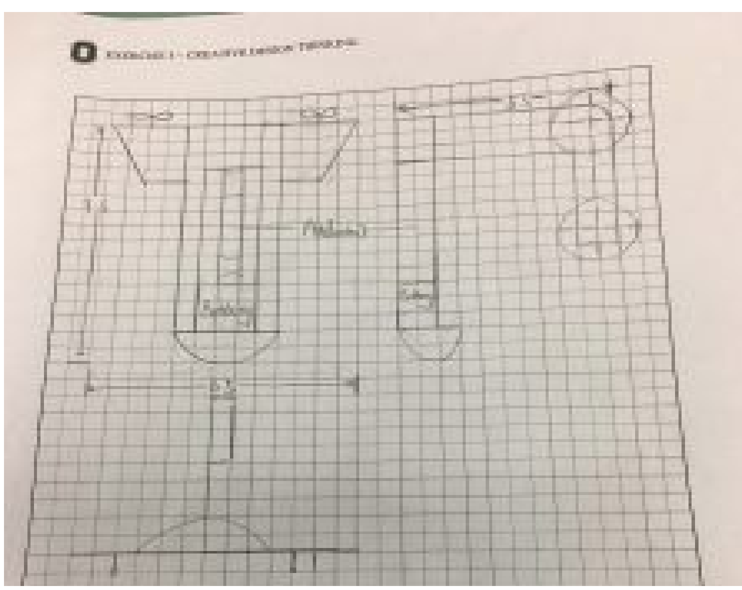

Figure 2: AEV designed by Tongshuai Zhang

The figure 2 shows that the battery is located at the front of the AEV (although not in the most frontest part)to generate even weight distribution. Also, the nose cone is in the front of the AEV to balance the aerodynamic and weight benefits.

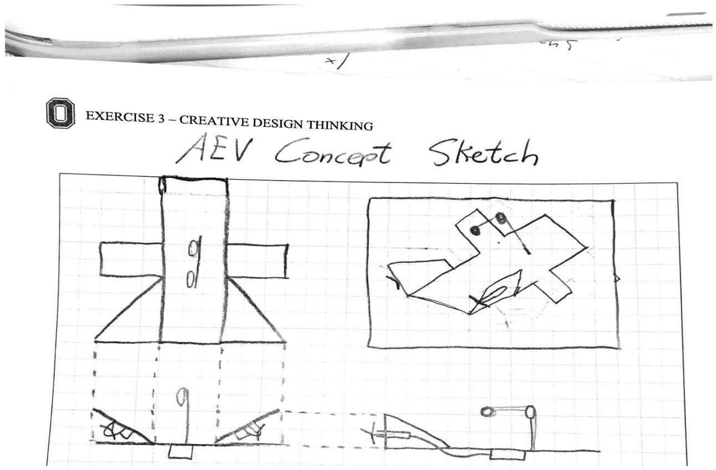

Figure 3: AEV designed by Jacob Dougherty

The figure 3 was done by using some of the structure of the sample AEV, but altering it to into what will be a more efficient way. The platform across the bottom will have a T shape so that there will be more area for passengers, and the motors will be attached at the back to propel it forward. The placement of the arduino will been under the platform in such a way that the weight is even across the AEV, giving maximum stability during use.

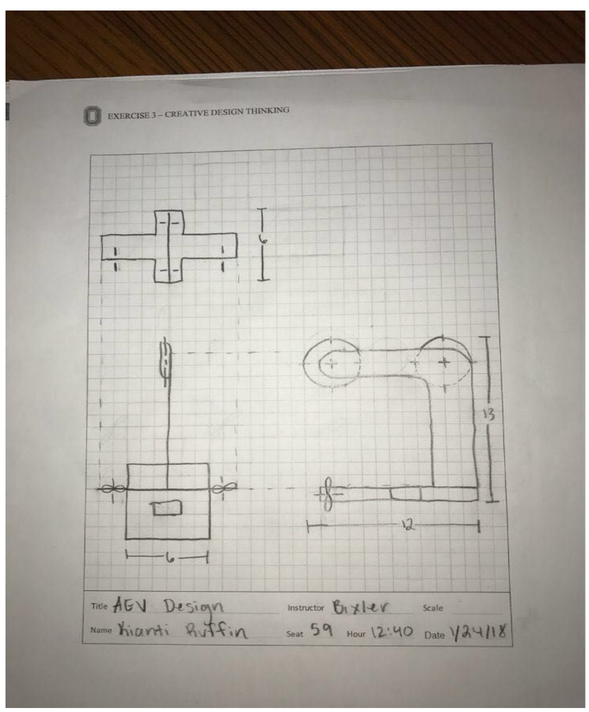

Figure 4: AEV designed by Kianti Ruffin

The figure 4 design for the AEV was created for maximum surface area for transportation, however still keeping the material costs low. The motors are on the far ends of the base in efforts to propel the AEV with the most control and efficiency. The arduino as well as the battery will be attached to the bottom in order to create more space for transportation.

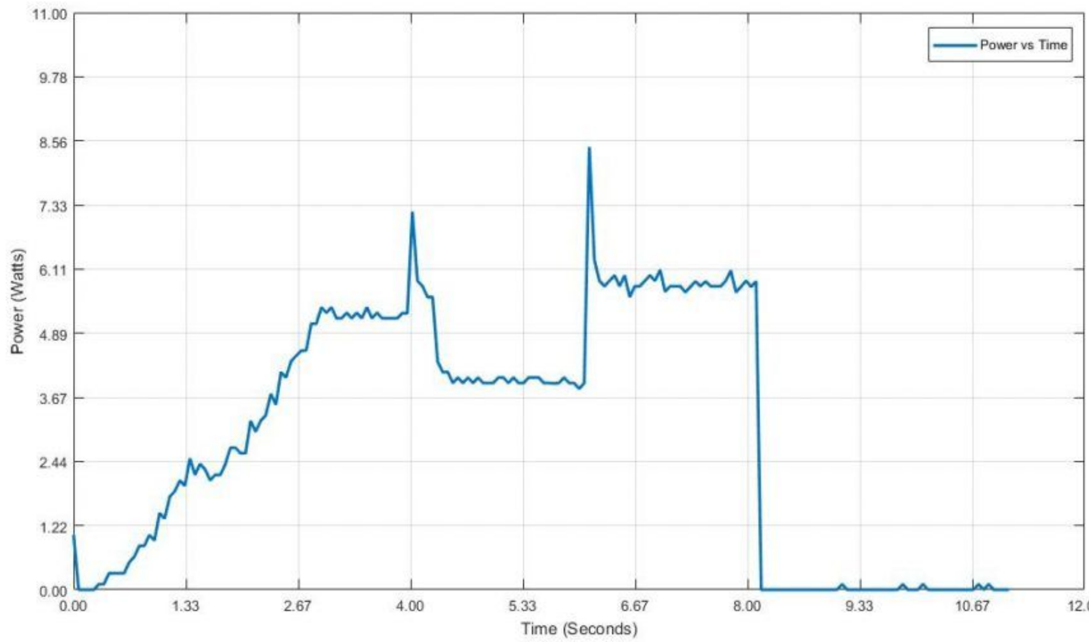

Figure 5: Power (Watts) vs. Time (Seconds)

Figure 5 displays the results from the Design Analysis Tool exercise. The graph shows the change in power transmitted to the motors of the AEV over time. First, as the power outputted to the motors accelerated both the motors at 25% power from t = 0 to t = 3 seconds which the slope of the graph increased as well.Then,the AEV maintain the motor speed at 25% power for 1 second,therefore,the power input remained constant from t = 3 to t = 4 seconds. Next, the AEV decreased the motor speed from 25% power to 20% power which caused the power input to decrease from t = 4 to t = 6 seconds. Additionally, the slope sharply increased around four seconds, which may have been due to a time gap in coding causing the motors to rest for a miniscule time interval. As the AEV switched direction around six seconds, the power energy input increases drastically to switch the power of the motors to the opposite direction. And the motors then run at 25% constant power for from t = 6 to t = 8 seconds. The power input decreased to zero at approximately eight seconds causing the AEV to come to a stop.

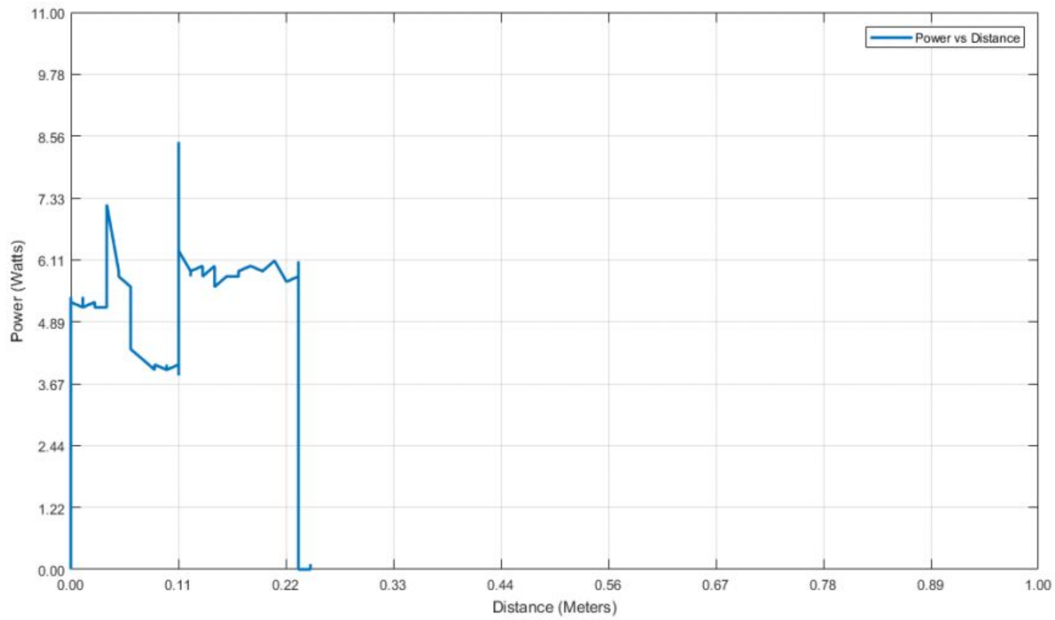

Figure 6: Power (Watts) vs. Distance (Meters)

$\Delta W = 1/2\ M(\Delta V)^2 = F * \Delta S$ *Equation (1)*

$F = M * \Delta V$ *Equation (2)*

Figure 6 shows a similar shape to that of Figure 5. The slope represents impulse, or the change in momentum under ideal conditions. Equation 1 below calculates how the electric energy was converted to the kinetic energy of motor. Equation 2 shows the slope is actually the impulse.When the AEV accelerates from rest to 25% power within the first few seconds, the slope increases sharply. As the motor reaches the power constant of 25%, the slope of the graph also becomes constant, displaying the AEV moving at a constant speed. As the power decreases to 20% for 20 seconds, the momentum decreases and the distance increases. The momentum drastically increases when the direction changes around 0.1 meters, and finally decreases as the AEV brakes and comes to a rest at approximately 0.2 meters.

Success Criteria	Reference	Kia's Design	Kezia's Design	Jacob's Design	Zhang's Design
Stability	0	-	0	0	0
Minimal Blockage	0	+	0	+	+
Maintenance	0	0	0	+	-
Durability	0	-	+	0	0
Safety	0	-	0	+	+
Sum +'s	0	1	1	1	2
Sum 0's	5	2	2	4	2
sum -'s	0	2	2	0	1
Net Score	0	-1	-1	1	1
Continue?	Combine	no	no	yes	no

Figure 7: Concept Screening Matrix

		Reference		Kia's Design		Kezia's Design		Jacob' s Design		Zhang's Design	
Success Criteria	Weight	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Stability	20%	3	0.65	2	0.3	3	0.65	3	0.70	3	0.65
MinimalBlocke	15%	3	0.40	4	0.7	3	0.40	2	0.45	4	0.65
Maintenance	15%	2	0.3	2	0.3	2	0.30	5	0.75	1	0.25
Durabiliy	25%	3	0.80	1	0.20	5	1.05	3	0.85	3	0.75
Safety	25%	3	0.70	3	0.80	3	0.95	2	0.85	4	1.10
Total score			2.85		2.3		3.35		3.6		3. 40
Continue?		No		No		No		Develop		Develop	

Figure 8: Concept Scoring Matrix

It was decided that Jacob's design would be used as the final design for further advanced testing and the rest of the project. Based on Figure 8, it as chosen to develop Jacob and Zhang's designs because of the scores they were given based on stability, durability, and overall effectiveness. Net scores were also given in Figure 7, and after carefully analyzing these charts it was found that Jacob's design was the best fit for the remainder of the project due to its balance between reliability, effectiveness, and ability to complete the given tasks.

Looking Forward

As the process of developing and creating an effective and efficient AEV continues, coasting vs. power breaking and battery testing will become the primary focus. Battery testing will be done to determine the relationships between voltage and number of test runs, along with voltage and distance travelled.

Variance testing for different batteries will be be able to illustrate differences in battery performance, as the battery rating when fully charged is 7.4 V, but may vary depending on how old batteries are, manufacturing variance, and amount of trials used in. Due to this, the variance in batteries is something that must be examined further, as it is currently unknown if this variance has the ability to make large or small changes in our data. This will be done by first obtaining a fully charged battery and recording its voltage at full capacity, followed by performing a test on the strait one track with code similar to what will be used in a normal run. Both voltage and distance readings will be taken during this trial, and following this two more batteries will be assessed to determine how great the differences are when different batteries are used. After all testing is completed, distance vs time and voltage vs time graphs will be created for each battery which will make the differences across the batteries easily visible in the graphs. From the data obtained, conclusions will be able to be formulated and more knowledge about the effects of the battery will be obtained. Delegation of tasks will be done based on what group members are best at, and to start John will be leading the coding for the trials. Kezia will be recording the meeting minutes for the testing, Kia will be analyzing the data that is collected during the trials, and Jacob will be controlling the AEV during testing along with making any updates if it is not functioning properly.

The concept of coasting vs power breaking will also be examined further. By understanding the differences between coasting and powerbeaking it will be determined which is the best fit based on the AEV being used by the team. This will be done by using two codes, with the only difference being that one uses power breaking while the other coasts. When the coasting code is tested, the forward distance travelled when the motors shut down and total distance travelled will be recorded along with the power (from the data analysis tool). This will be repeated 8 times, and following that a new battery will be obtained for the power breaking testing. The power breaking trials will be very similar, with the distance at which the motors begin to reverse being recorded along with total distance travelled, and the power will be recorded with data analysis tool will the same. Following 8 trials of power breaking, the data will be gathered and examined in order to determine which is the best fit for the given AEV concept. John will be providing the code for this test, Jacob will be ensuring the AEV is ready for both types of tests, Kia will be ensuring the correct use of the power recording tool, and Kezia will be recording meeting notes along with checking the distances travelled by the AEV for each test. Through this delegation, the effectiveness of both coasting and power beaking will be determined, and a decision of which would be more effective for the given AEV design will be made.

Through these testing methods, determinations about both the effect of different batteries and what the most effective way to slow down will be determined, which will give the AEV design the ability to become more cost and time effective, leading to a better overall design proposal.

Appendix

Team Meetings

Meeting 1

Date: 01/10/2018
Time: 12:40 pm
Location: Hitchcock 224
Members Present: All
Topics Discussed: Preliminary R&D Exercises 1 and 2, Arduino Programming, Propellers, Motors, and Sensors

Objectives:
Complete Exercises 1 and 2, which involved testing the motors and the sensors. Answer the Progress Report Questions after each exercise. Document Meeting Notes 2.

To Do:
- Finish Sensor Tests next lab.
- Upload Meeting Notes on the website – Kezia
- Objective:
- The main focus of today's meeting was to discuss the basic layout and content of the website and to
- delegate tasks for the development of different aspects of the website to different team members.
- Team Meeting Minutes document (JS, HS)
- Website Update 1 (PF, RPB, HS)
- Decide what information needs to be included in the contact information section (Everyone)

Decisions:
- The team decided to include each member's name, OSU email, a picture, and major in the

- contact information tab of the website.
- The team chose the active theme “Ohio State Dark” because of its simplicity (suggested by JS)
- It is too early to assign specific tasks to group members. When work needs to be done it will be
- coordinated through GroupMe.

Reflections:

- Dividing workload is an effective approach.
- Technical communication guide is a helpful resource.

Meeting 2

Date: 01/17/2018
Time: 12:40 pm
Location: Hitchcock 224
Members Present: All
Topics Discussed: Preliminary R&D Exercises 1 and 2, Arduino Programming, Propellers, Motors, and Sensors

Objectives:

Complete Exercises 1 and 2, which involved testing the motors and the sensors. Answer the Progress Report Questions after each exercise. Document Meeting Notes 2.

To Do::

- Finish Sensor Tests next lab.
- Upload Meeting Notes on the website – Kezia

Meeting 3

Date: 01/24/2018
Time: 12:40 pm
Location: Hitchcock 224
Members Present: All
Topics Discussed: Preliminary R&D Exercises 2, 3, and 4, Sensor Test, AEV Design, Motor Direction, Meeting Notes

Objectives:

Complete Preliminary R&D Exercises 2, 3 and 4. Answer the respective Progress Report Questions. Individually create AEV designs and document them.

To Do:

- Complete Website Update 2 – Jacob, John, Kezia, Kia
- Upload Meeting Notes – Kezia

Meeting 4
Date: 01/31/2018
Time: 12:40 pm
Location: Hitchcock 224
Members Present: All
Topics Discussed: Preliminary R&D Exercises 2 and 4, AEV Design, Meeting Notes 4

Objectives:
Complete Sensor Test and Exercise 4 Questions. Complete Progress Report Questions

To Do:
- Document Meeting Notes – Kezia
- Upload Progress Report – Kezia
- Get in contact with our company to discuss lab topics – Kia
- Email Isa about our topics by Sunday – Jacob and John

Arduino Code

Programming Basics Exercise(01)

```
// Accelerate motor one from start to 15% power in 2.5 seconds
celerate(1, 0, 15, 2.5);
// Run motor one at 15% power for 1 second
motorSpeed(1, 15);
goFor(1);
// Brake motor one.
brake(1);
// Accelerate motor two from start to 27% power in 4 seconds
celerate(2, 0, 27, 4);
// Run motor two at a constant 27% power for 2.7 second
motorSpeed(2, 27);
goFor(2.7);
// Decelerate motor 2 to 15% power in 1 second
celerate(2, 27, 15, 1);
// Brake motor 2
brake(2);
// Reverse the direction of motor 2
reverse(2);
// Accelerate all motors from start to 31% power in 2 seconds
celerate(4, 0, 31, 2);
// Run all motors for 35% power for 1 second
motorSpeed(4, 35);
```

```
goFor(1);
// Brake motor 2 and keep motor 1 at 35% for 3 seconds
brake(2);
motorSpeed(1, 35);
goFor(3);
// Brake all motors for 1 second
brake(4);
goFor(1);
// Reverse the direction of motor 1
reverse(1);
// Accelerate motor 1 from start to 19% in 2 seconds
celerate(1, 0, 19, 2);
// Run motor 2 at 35% power while running 1 at 19% in 2 seconds
motorSpeed(2, 35);
motorSpeed(1, 19);
goFor(2);
// Run all motors at 19% for 2 seconds
motorSpeed(4, 19);
goFor(2);
// Decelerate all motors 50 0% in 3 seconds
celerate(4, 19, 0, 3);
// Brake all motors
brake(4);
```

ExternalSensorsOutside Exercise(02)

```
// Run all motors at 25% power for 2 seconds
motorSpeed(4, 25);
goFor(2);
// Run all motors at 20% power to absolute position 12 feet
motorSpeed(4, 20);
goToAbsolutePosition(295);
// Reverse all motors
reverse(4);
// Run all motors at 30% power for 1.5 seconds
motorSpeed(4, 30);
goFor(1.5);
// Brake all motors.
brake(4);
```

Design Analysis Tool Exercise(04)

```
// Accelerate and run all motors at 25% power for 3 seconds
celerate(4, 0, 25, 3);
```

```
// Run all motors at 25% power for 1 second
motorSpeed(4, 25);
goFor(1);
// Run all motors at 20% power for 2 seconds
motorSpeed(4, 20);
goFor(2);
//Reverse all motors
reverse(4);
// Run all motors at 25% power for 2 seconds
motorSpeed(4, 25);
goFor(2);
// Brake all motors
brake(4);
```