ENGR 1182 Progress Report 3 - Group C

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Lab 9:

Backwards Looking Summary:

To prepare for this lab, the group discussed what needed to be done for the first performance test. After looking at the rubric, the procedure that the AEV must follow in order to get full credit was determined. The AEV must be able to start up from inside the first zone, which is behind the red tape on the monorail, then proceed to the gate in the middle and stop close enough to activate the sensor. Once the AEV has stopped at the gate and triggered the sensor it must wait seven seconds for the gate to open and be able to proceed through the open gate without any collision and safely stop at any point beyond the gate. The safety precautions that must be taken for this performance test were that there must be at least one group member close enough to the AEV that they could quickly stop and retrieve the vehicle in case of failure.

The lab period consisted of multiple trial runs where various parts of the code were tested, mainly fine-tuning it in order for the vehicle to stop neatly in front of the gate without falling short or slamming into the gate. After a few successful test runs, the team called a TA over to oversee a run for an official grade which was passed for full credit. The first performance test was completed during Lab 09b on Monday, March 19th, **Code 1**. After the first performance test was completed, the immediate next step was discussing any changes that needed to be made for the second performance test. After a couple quick test runs with slightly modified code from the initial performance test to prepare for the second, a design flaw was noticed in that the angle bracket at the nose of the vehicle was too low to securely attach to the magnetic hitch of the caboose. This was a quick fix where the bracket was rotated on the base so that the longer leg was made perpendicular to the base, instead of attached to it, **Figure 1**. The takeaways from this lab week included a better understanding of what the group's AEV design needs to adapt to in order to fulfill all of the performance tests, and that all input from team members in the design process is valuable and should be properly considered.

Forwards Looking Plan:

In the next lab, the group needs to continue trial runs for the second performance test. Only slight modifications need to be made from this point onward. In order to make the code for the testing more easily debugged and troubleshot, Matthew converted as much of the code as he could into various functions, so that if a problem arose in several trial runs and the area of fault could be determined on the track then it would be easy to go in and find the error in the code and make adjustments, **Code 4**.

The difference in the requirements for each performance test is not much, but keeping consistency in every trial is of the highest importance. There is a lot of room for fine tuning, so much of the testing that needs to be done is efficiency based, such as power usage and cutting any unnecessary time off the runs. Accurate braking is also very important, so with small adjustments in each run and the combination of coasting and power braking, a lot can be done in this area. One of the requirements for the second performance test is to be able to attach the caboose to the AEV without any large recoil that caused the caboose to leave the loading zone prematurely, so accurately braking and slowly coasting into the caboose for a gentle attachment is crucial to work on.

Lab 10:

Backwards Looking Summary:

During this lab week, the highest priority was finishing the second performance test. After referring to the rubric in the MCR for this assignment, the specific steps that the group's AEV needs to take could be determined. The majority of the test is exactly the same as the first performance test with just a small addon with the use of the caboose. After the AEV goes through the normal procedure of going through the gate, it must now be able to gently attach itself to caboose in the loading zone at the end of the monorail opposite from the starting position. Once it attaches itself, it must be able to wait a full five seconds with it attached, and then proceed in the opposite direction that it came in and safely stop at any point where the caboose is outside of the loading zone. Some safety precautions, in addition to the ones from the first performance test, would be that the caboose must not aggressively recoil off of the stopper on the end of the track and prematurely make its way outside of the loading zone, and arduino on the AEV must not be within two square inches of the magnet on the caboose.

The trial runs for this performance test began during the week of Lab 9. It was already determined that a design change needed to be made to the metal angle bracket at the nose for the AEV to attach itself to the caboose safely and securely. The initial tests brought up problems with the AEV being able to stop in time to gently attach to the caboose. It was determined that a small error in the code made it so that the AEV incorrectly determined the time to stop. Once this fix was made, it just took a few test trials and small changes in the code to perfect the attachment process of the AEV to the caboose. After this accomplishment, all that was required to finish the performance test was a five second delay and a motor reversal to get the caboose out of the loading zone. The second performance test was completed during Lab 10b on Monday, March 26th, **Code 2**. The takeaways from this lab week were that the success of the AEV during performance tests lies in the details of the code and making sure all the numbers work well together, and that group discussion over finding the best and most efficient code must be done for the most quality results.

Forwards Looking Plan:

During this lab week, the team ran into an issue while beginning testing for the final performance test. After the second performance test was completed, the group started doing further trial runs in preparation for the final test, but noticed that there was a design flaw in the general shape of the AEV that required a change. It was noticed that the AEV was too long for it to get through the gate with the caboose attached in the time between when the gate opens up and when it closes.

In the next lab, the team needs to redesign the AEV to reduce its length. In addition, subsequent tests must be performed in order to bring the AEV back to full functionality along the track. Because the mass of the AEV has changed, so also will its momentum (**Equation 1**), but it is uncertain by how much, and testing must be performed in order to change the code so the AEV will go the same distances and speeds travelled before.

Lab 11:

Backwards Looking Summary:

In lab 11 the group was able to focus on testing for the final performance test.The results of lab 10 proved that the group needed to redesign the AEV. The AEV was too long, and triggered the STOP sign to close before the caboose was clear of it. This resulted in the AEV getting stuck on most runs. Consequently, during Lab 11, Group C determined the new and final orientation for the AEV. To cut down the length of the AEV, the group determined that moving the arduino back slightly and removing a section of the base was the best option for cutting the length. To compensate for this change, the magnet was placed on the opposite side of the AEV, behind the arm. This resulted in some changes that the group then had to account for.

The first change was the direction change. This was fixed by removing the reverse at the start of the code which had previously been needed there. On the initial test of the new design, the group found that the AEV was accelerating more quickly than before. This was surprising as there was only a slight change in weight from removing the extra part the magnet was attached to. As a result the AEV was able to go farther on the same power setting. This caused the group to change the code to compensate, setting lower powers and running the propellers for less of the distance, resulting in the current and final code, **Code 3**. Once the changes were made to the code, the runs were tested again to see if they worked and they did, and the AEV was able to make a full run successfully multiple times in a row with the new design. The takeaway for the AEV was that smaller, more compact designs can be better when executed carefully, and the takeaway for the team was that good communication about issues and fixes can be very efficient for working toward a solution.

Forwards Looking Plan:

The next step for the AEV will be to decrease the energy used. The AEV can currently complete the final test, but uses more power than the group would like, at 348 Joules, which costs $174,000. The team will need to work on refining the code to be energy efficient so that they can use the least possible amount of energy. To do this, the team will need to do multiple test runs with different code, so that they can minimize the energy spent braking while ensuring the AEV gets to its destination. They will also need to work on minimizing the amount of time that the runs take, to cut down on costs. This will also require tweaking the code, being careful to avoid using more power than needed.

Appendix

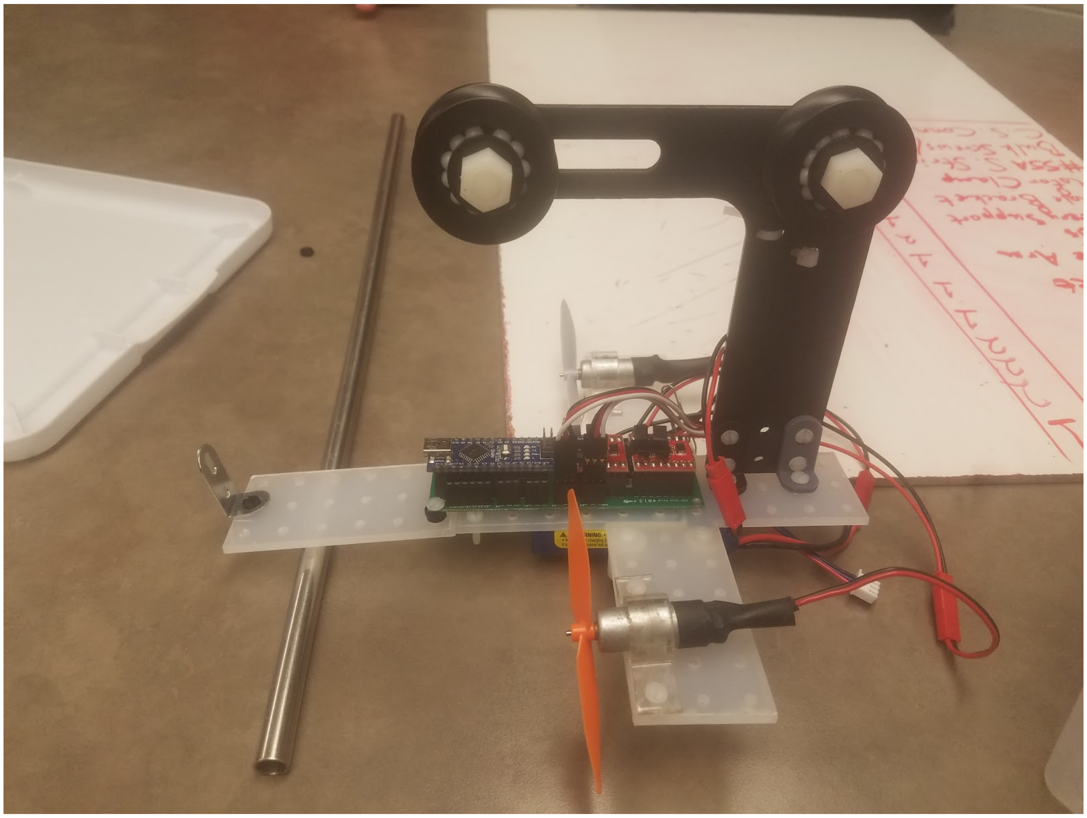

Figure 1 - AEV Design #2

Equation 1 - Momentum (p)

$$p = mass * velocity$$

Code 1 - Performance Test 1:

```
goToAbs(294, 40, 50);
stopAEV();
delay(8000);
goToAbs(600, 40, 20);
stopAEV();
```

Code 2 - Performance Test 2:

```
goToAbs(294, 40, 50);
```

```
stopAEV();
delay(8000);
goToAbs(600, 40, 20);
stopAEV();
delay(5000);
goToAbs(300, 50, 63);
stopAEV();
delay(7000);
```

Code 3 - Current Code

```
goToAbs(294, 30, 50);
stopAEV();
delay(7000);
goToAbs(635, 30, 20);
stopAEV();
delay(5500);
goToAbs(377, 55, 67);
stopAEV();
delay(7000);
goToAbs(10, 40, 30);
stopAEV();
```

Code 4 - Functions

```
void stopAEV() {
  // Direction: 1 = Forward; 0 = Reverse, 2 = No Direction.
  // the encoderPos-((dir*4)-2) will, if dir is forward, be behind the AEV, and if dir is reverse be in front of the AEV,
  // resulting in a target which is in the opposite from the velocity
  boolean didReverse = runToward(encoderPos-((dir*2)-1), 40); // Moves the motors in the opposite direction of travel

  // The below section waits until the AEV travels very slightly in the other direction or the gap between encoder count increments is long enough
  // If the gap between encoder count increments is high, the AEV is slow, and the propellers can stop
  int currentDir = dir; // dir is a global variable
  int delayFor = 70; // Tune this to change how slow the AEV will be, the smaller the faster
  int pastEncoder = encoderTotal; // encoderTotal is a global variable
  delay(100); // Initial delay so it doesn't check pastEncoder to encoderTotal immediately
  while (pastEncoder!=encoderTotal && currentDir==dir){
    pastEncoder = encoderTotal;
    delay(delayFor);
```

```
  }

  brake(4);
  if (didReverse) reverse(4);  // reverses motors back to original if needed
}

// This function moves the AEV to the given position, using power for the first half and coasting
for the second half
void goToAbs(int pos, int power, int runPercent) {
  boolean didReverse = runToward(pos, power); // Runs toward target direction, returns whether
it had to reverse motors to do so
  int disTillStop =(int) ((runPercent/100.0) * abs(pos-encoderPos));
  if (pos>encoderTotal) {
    goToAbsolutePosition(disTillStop+encoderPos);
  }
  else {
    goToAbsolutePosition(encoderPos-disTillStop);
  }
//  goToAbsolutePosition((pos+encoderPos)/2);
  brake(4);
  goToAbsolutePosition(pos);
  if (didReverse) reverse(4); // reverses motors back to original if needed
}

// This function sets the motors toward the given pos, at the given power
boolean runToward(int pos, int power) {
  if (pos>encoderPos){ // Checks whether to run forward or backward
    motorSpeed(4,40);
    return false;
  }
  else {
    reverse(4);
    motorSpeed(4, 40);
    return true;
  }
}
```

Team Meeting Notes

Meeting 10 – Lab 9

March 6, 2018

Time: 9:35 PM – 10:55 PM

Location: Hitchcock 224

Members Present:

Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Performance Test Day 1**
2. **Configuring first AEV design (Joe) to work properly**
3. **Troubleshooting Code**
4. **Working on Progress Report**
5. **Testing debugged code**

Goals for Next Meeting:

- **Finish Progress Report**
- **Update AEV to fix complications**
- **Continued performance testing**

Meeting 11 – Lab 09b

March 19, 2018

Time: 8:00 AM – 8:55 AM

Location: Hitchcock 224

Members Present:

Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Completed Performance Test 1**
2. **Fixed battery location on AEV**
3. **Discussed CDR Draft Roles**

Goals for Next Meeting:

- **Begin Testing for Performance Test 2**
- **Work on CDR**

Meeting 12 – Lab 09c

March 20, 2018

Time: 9:35 AM – 10:55 AM

Location Hitchcock 224

Members Present:

Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Worked on CDR Draft**
2. **Discussed a second AEV design**

Goals for Next Meeting:

- **Finish CDR Draft**
- **Work on Performance Test 2**

Meeting 13 – Lab 10a

March 22, 2018

Time: 8:00 AM – 8:55 AM

Location Hitchcock 224

Members Present:

Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Tested code for Performance Test 2**
2. **Modified AEV to attach to the caboose**

Goals for Next Meeting:

- **Finish Performance Test 2**

Meeting 14 – Lab 10b

March 26, 2018

Time: 8:00 AM – 8:55 AM

Location Hitchcock 224

Members Present:

Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Finished Performance Test 2**

2. **Code Debugging**

Goals for Next Meeting:

- **Begin preparations for Committee Meeting**
- **Work on Final Performance Test**

Meeting 15 – Lab 10c

March 27, 2018

Time: 9:35 AM – 10:55 AM

Location Hitchcock 224

Members Present:

Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Testing for Final Performance Test**
2. **Redesigning the AEV**
3. **Working on Website**
4. **Calculating Total Cost of AEV**

Goals for Next Meeting:

- **Committee Meeting 2**

Meeting 16 – Lab 11a

March 29, 2018

Time: 8:00 AM – 8:55 AM

Location Hitchcock 224

Members Present:

Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Committee Meeting 2**
2. **Testing Redesigned AEV**
3. **Compensating power usage for redesigned AEV**
4. **Updating Code**
5. **Updating website**

Goals for Next Meeting:

- **Continued code development**
- **Begin writing Progress Report 3**

Meeting 17 – Lab 11b

April 2, 2018

Time: 8:00 AM – 8:55 AM

Location Hitchcock 224

Members Present:

Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:

1. **Updating Code**
2. **Continued development towards final performance test**

Goals for Next Meeting:

- **Continued code development**
- **Begin writing Progress Report 3**

Meeting 18 – Lab 11c

March 5, 2018

Time: 8:00 AM – 8:55 AM

Location Hitchcock 224

Members Present:

Joe Jerig, Matthew Zirbel

Activities:

1. **Writing Progress Report**
2. **Repairing arduino (wire fray)**

Goals for Next Meeting:

- **Finish Progress Report**
- **Finish Final Performance Test**