Group J - Matthew Caldwell, John Kim, Jacob Phillips, Tarun Pilli Progress Report Week 2

Instructor - Dr. Philip Schlosser, GTA - Melissa Hrivnak 2/3/2017

Week 2

Situation

This week's lab involved two parts. The first half involved gaining familiarity with the external sensors the Arduino is compatible with. A reflectance sensor combined with a wheel with reflective tape on it can function as a mechanism for measuring distance, in the case of the AEV. Two sensors were mounted to the upright arm of the prototype AEV design with screws, and then further secured with zip ties. Holes in the arm allowed the sensors to "see" through to the other side where a mounted wheel with a reflective spot spun. As the sensor counted each sight of the reflective spot, distance travelled could be derived using the wheel's circumference. The sensors were first tested with the Arduino program's Serial Monitor to verify if they were functioning properly as well as accurately indicating which direction was forward or backward. Once this was ensured, new function calls for interacting with the sensors were introduced. These allowed for utilization of the distance-measuring functionality the sensors provide by giving the ability to specify a specific distance (absolute or relative) for the AEV to travel. These commands were used to write a basic control program for the AEV, meant to bring the machine from the start position to the gate system. The program was then tested on the overhead track.

The second part of the lab involved wind-tunnel testing to learn about propeller configurations and propeller efficiency. As a vehicle's propulsion efficiency is determined by motor efficiency and propeller efficiency, it was desirable to find which propeller design is most efficient. Wind tunnel testing was used in order to find the most efficient propeller, propeller configuration, and operating condition. Propulsion efficiency could be determined in this setup by comparing output and input power. Output power was determined by a function of vehicle velocity, propeller RPM, and propeller diameter, as well as the non-dimensional variable of Propeller Advance Ratio. In the wind tunnels, two different propeller configurations were considered: pusher and puller. In each configuration, power in the wind tunnel was slowly decremented with data collected at each setting for percent power, current, thrust, and RPM. These tests were performed on two propeller designs. Calculations were then performed to find calibrated thrust, power input, power available, propulsion efficiency, and propeller advance ratio. The data were plotted in order to gain a clearer picture of what they meant.

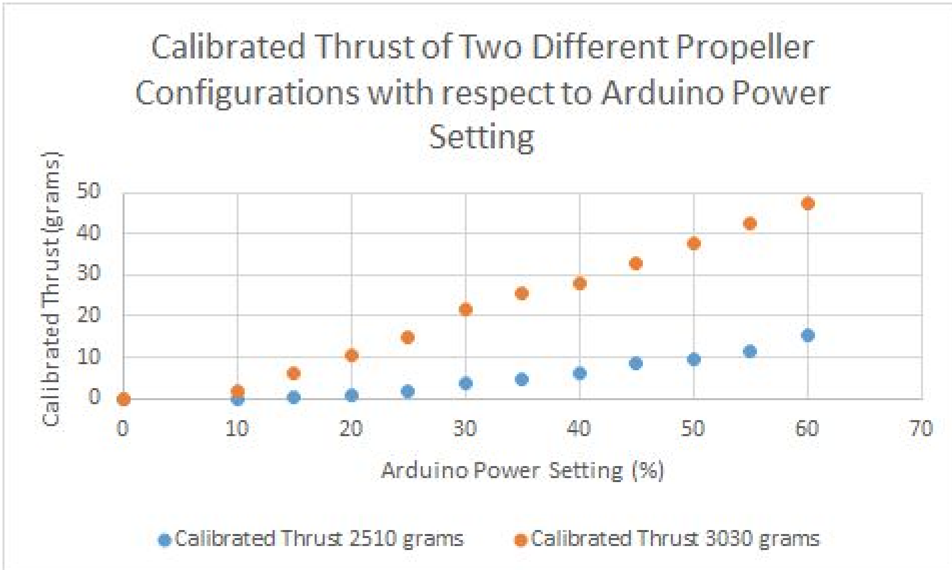
Results and Analysis

The group was successfully able to test the reflectance sensors within the Serial Monitor. Initial readings showed reversed directions for forwards and backwards, so the connectors for each sensor were switched, then giving correct readings. The test program was coded for the inside track using the new program function calls utilizing the external sensors. It was then uploaded to the Arduino for a test on the ceiling. Initial trial runs were unsuccessful, as the AEV moved in the opposite direction desired. Thus, the code was modified to reverse the directions of the motors at the beginning. This resulted in the propellers spinning in the proper direction and the AEV travelling forward. Successive test runs were more successful, as the AEV moved toward its goal point, albeit at a slow pace. The AEV also had difficulty getting itself started, and sometimes needed to be tapped in the right direction for the propulsion to begin. The team was not able to get the AEV all the way to the gate system due to lack of time, but further troubleshooting of the code would have solved the problem.

Data gathered and calculated through this lab compared two separate propeller configurations, the Puller 3030 configuration and the Puller 2510 configuration. Parameters such as RPM, thrust, current, and the arduino power percent were directly measured and recorded, while other parameters, such as, calibrated thrust, input and output power, propulsion efficiency and advance ratio. These values were determined for both propeller configurations. Graphs were created in order to provide a visual comparison. These graphs are included below.

The first graph, displayed below, demonstrated the calibrated thrust of both configurations at the same Arduino Power Setting. It can be seen that as the power setting increased, the calibrated thrust of the 3030 configuration radically departed from the calibrated thrust of the 2020 configuration. With more thrust, the AEV will, in the future, be better suited for quick and efficient travel.

Figure 1: Calibrated Thrust of Different Propeller Configurations



The next two graphs displayed showcase the propulsion efficiency each configuration has with respect to their own advance ratio. While Propeller 2510 has an unexpected and irregular curve, the graph of Propeller 3030 follows the expected trendline. It was noted that the maximum efficiency Propeller 2510 reached was about 17%, while the maximum efficiency Propeller 3030 reached was around 55%.

Figure 2: Propulsion Efficiency of Puller 2510 Configuration

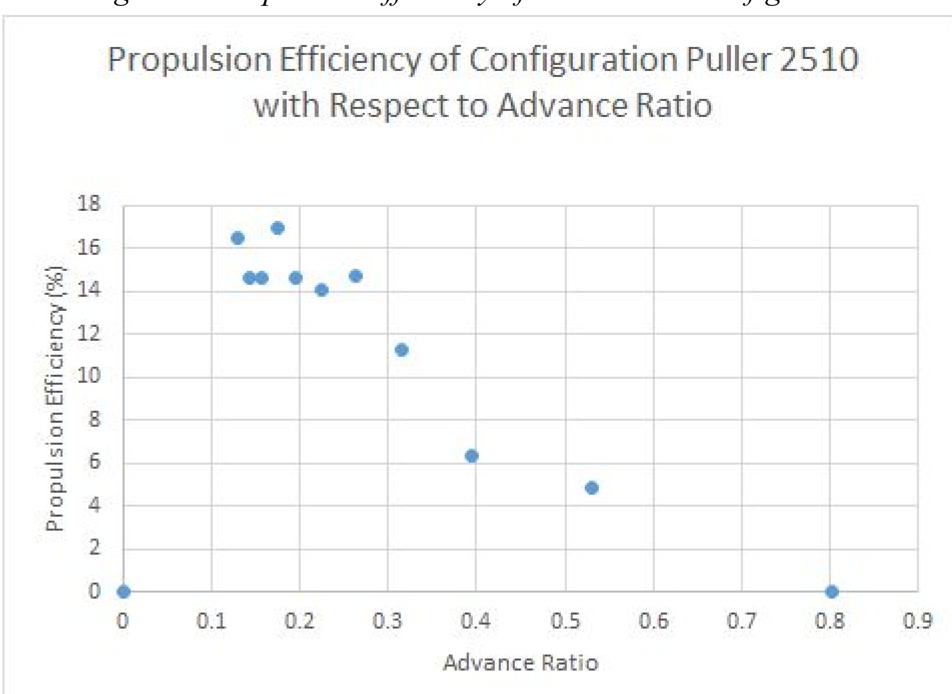
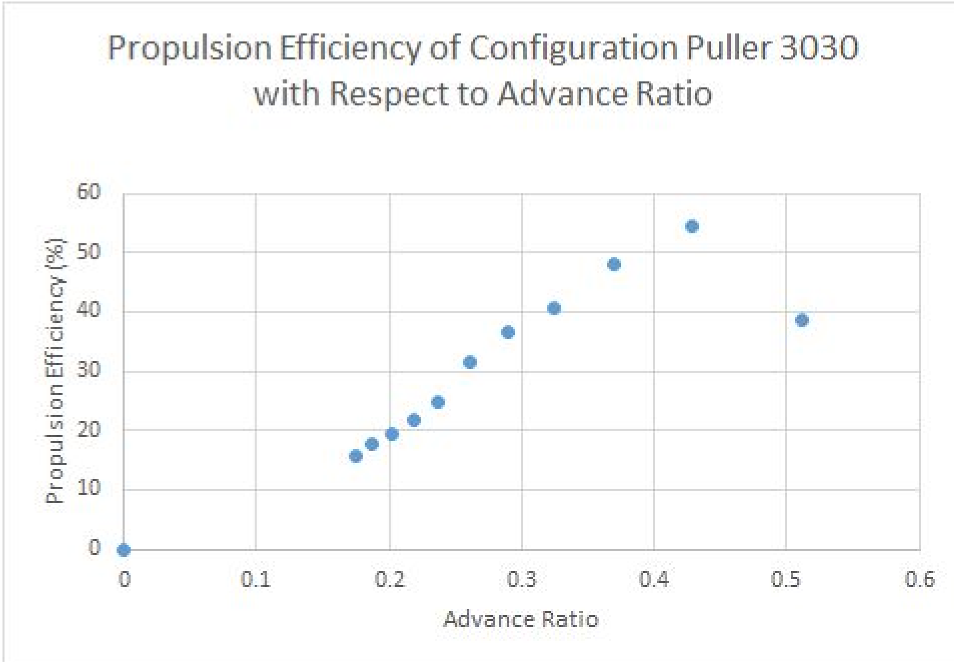


Figure 3: Propulsion Efficiency of Puller 3030 Configuration



Throughout the activities performed in the second half of the lab, the group gained familiarity with both wind tunnel testing equipment and propulsion efficiency, while also learning of the pusher and puller configurations, and real-life applications of these configurations. The wind tunnel testing also exhibited the overall superiority of the puller 3030 configuration, and therefore, the group had decided to incorporate the puller 3030 configuration into the final design of the AEV.

The maxima in the graph of propeller 3030's propulsion efficiency occurred when the advance ratio was approximately 0.42. When the advance ratio was at 0.42, the Arduino power setting was at 15%. At 15% power, the 3030 configuration achieves about 55% efficiency. Running the motors at 15% will maximize the efficiency of propulsion. Based on this info, the group will proceed to implement the code 'motorspeed(4, 15):' in the future. This code will run the most efficient propulsion system for the AEV.

<u>Takeaways</u>

1) AEV- The AEV moves along the track by two propellers being powered by two separate motors. Half of lab consisted of gathering data about each type of propeller available for use in the AEV kit. Propeller 3030 produced more calibrated thrust as the arduino power setting increased, meaning that the 3030 propeller would be able to move the AEV farther at a lower power setting. When the AEV maneuvers around turns, it is required that its' power setting decrease in order for it to not fly off of the overhead track.

Propellor 3030 will be able to move the AEV around the turns at a lower power which will increase safety and prevent it from flying off the track. Group J will move forward in the project with the 3030 propellor being used over the 2510.

2) General- Lab 2 was the first lab where time management became a problem. Group J was not successful in completing the first part of the lab as the testing of the sensors, completion of the construction of the AEV, and gathering of data from the wind tunnel took up much of the lab time. Also, the Progress Report for Lab 2 needed quality improvement which increased the workload for the week leading up to lab 3 as two progress reports needed to be completed. It is important for the group to manage time better and meet project deadlines on time in order to not fall behind on the progression of the AEV project.

Week 3

Situation

In the coming week, the group will be exposed to the idea of creative design thinking. The group will learn the two techniques used for creative design thinking, become familiar with obstacles to creativity, become familiar with components in the AEV kit, learn the basic of orthographic drawings, and to brainstorm on individual AEV concept sketches. The group members will be coming into class prepared with a sheet of orthographic paper and will be constructing an orthographic design of the AEVs. For the first fifteen minutes of class, each group member will independently brainstorm a potential design for the AEV. Once this is done, group members will come together for another fifteen minutes to present their own ideas and come up with one design of the AEV.

Weekly Goals

1) Finish Progress Report 2 and improve the quality of Progress Report 1.
2) Prepare for Lab 3 by reading the lab manual before class, and completing the quiz.

Weekly Schedule

Task	**Teammate(s)**	**Start Date**	**Due Date**	**Time Needed**
Complete Progress Report 2	All	1/26/17	2/3/17	3 Hours
Improve the quality of Progress Report 1	All	2/3/17	2/7/17	1 Hour
Prepare for Lab 3	All	1/30/17	1/31/17	30 Minutes

Appendix A

Date: 2/3/17
Time: 3:00 P.M.
Members Present: Tarun Pilli, Matthew Caldwell, & Jacob Phillips
Topics Discussed: Progress Reports for Lab 2 and Lab 3.

Objective:
Part of the group met in order to complete the Progress Report for Lab 3, as well revise as to improve the quality of the Progress Report for Lab 2.

Tasks:
-Progress Report for Lab 2
The Progress Report for Lab 2 was revised in order to improve the quality before resubmission. Each member participated in this task and the revision was completed hastily.
-Progress Report for Lab 3
Part of the progress report for Lab 3 was completed before the team meeting, but much work had to be completed during the meeting in order to complete the assignment on time.

To do/Action Items:
-Add both progress reports to the project portfolion at U.osu.edu before lab 4(All members)
-Complete the Progress Report for Lab 4 and add it to the project portfolio before lab 4(All members)

Reflections:
Group J continued to work well as a unit and was able to complete the Progress Report for Lab 3 on time, as well as making the proper revisions to the Progress Report for Lab 2 in order to improve the quality. Even though not all group members were able to make the meeting, the report was still worked on periodically whenever each member had time.

Appendix B

Arduino Code for inside track test-run

```
reverse(4);
motorSpeed(4, 25);
goFor(2);
motorSpeed(4, 20);
goToAbsolutePosition(332);
reverse(4);
motorSpeed(4, 30);
goFor(1);
brake(4);
```

Appendix C