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Progress Report Week 3

Instructor: Omar El Khoury 2/2/2017

**Week 3:**

Situation

This week, the team completed Lab 2, which concerned the external sensors and propellers. Lab 2a was an essential part of designing the AEV. The team became familiar with with the external sensor hardware components and learned how to troubleshoot code related to the sensor. The team also learned how to program function calls for use with the external sensors. Understanding how the sensors work and how they are utilized in the AEV is crucial because, without a full understanding of the sensors, the AEV cannot be used on the track. Lab 2a was also an important step in the design process. The team became familiar with propulsion system efficiency and a wind tunnel testing procedure. Wind tunnel testing was necessary to determine which propellor was most efficient. If the team decides to design their rotor blades, wind tunnel provides useful baseline data to use for comparison with the new propeller designs. Lab 1 went very smoothly. All the equipment worked correctly, and errors in the code did not slow the team down. The only trouble that the team experienced during the lab was setting up the sensors. There were clear instructions in the lab manual, but the team still struggled with this step.

Results and Analysis

The purpose of Lab 2a was to install and test the reflectance sensors on AEV. First, the team had to calibrate the reflectance sensors to be sure that they were correctly reading movement. After a few adjustments, this task was completed with the sensors responding appropriately. The Arduino program settings needed to be tweaked but afterward appeared to function as intended; the motors started, stopped, and reversed as programmed. There was slight confusion initially when the propellers kept spinning for a long time, but the team realized that this was because they would only stop once the AEV had reached its final distance. Upon lifting the AEV and spinning the wheel, the motors worked as expected. This is beneficial because this means that, not only are the reflectance sensors working, the Arduino code does not have any noticeable flaws. The team did not test the AEV on the track, but rather on the tableside setup. The first time that the team tried to test the sensors, the data revealed that the wires were connected backwards. The team should keep this error in mind in future testing. The knowledge gained in Lab 2a will be combined with the knowledge gained in Lab 1 to write preliminary code for the scenario stated in the mission concept review. Controlling the speed will be a critical component to maximize efficiency. The sensors will be used to keep the movement of the AEV precise. Based on the knowledge that the group has gained from this lab, the coding must be altered slightly. Although the program tells the AEV to travel a certain distance or brake at a certain time, the actions of the AEV are not exact. The engines will cut once the marks have been reached, but the AEV will slide a little farther before coming to a halt. Likewise, when the brake command is utilized, the AEV does not actually slow itself down, it just cuts the engines. Therefore, it may not be stopping at the exact place that the group wants. Through testing, the team will have to come up with a program that, though it may not appear to do exactly what the Mission Concept Review requires, will execute correctly and direct the AEV through the correct actions.

Analyzation of the data table will help in two aspects. The first will be deciding which propeller diameter will be the most efficient. The average efficiency of the larger propeller (3.030 in diameter) is 12.001 % and the smaller (2.510 in diameter) is 5.773 %, making the larger propeller a better choice. The next important piece of data is the power percentage which is the most efficient. 20 % power outputted 13.15 % efficiency which is the highest. This information will be useful when coding future procedures. The team will have to find a balance between speed and efficiency. Minimizing power usage is an important component to the AEV project and this data will have a direct impact on the AEV design and code. Graph 1 refers to the thrust generated by the propeller and the percent power. Graph 2 refers to the efficiency and the advance ratio. These graphs help describe the performance the of the 0.3030 propellor. While thrust increases with a higher percent power, the efficiency flattens out over time.

Takeaways

1. The 0.3030 inch propellor blade is more efficient and should be used in the final design.
2. The team will make sure that the sensors are connected to the arduino correctly so that the readings are reasonable.
3. The team will try to keep the sensors clean and smooth. It was discovered that dirty sensors provide inaccurate data

**Week 4:**

Situation

During Week 3, the team’s primary goal will be to develop skills in coding and data analysis. The first objective will be to develop a code that can operate on the actual track system. This is important because the engineers must be able to understand the coding necessary to complete the task. The track will present challenges that the engineers have not encountered in the previous pseudo-code. Being able to operate the speed and position of the longer course will be vital for further coding. This introduction to movement will allow for stronger code building in the future.

An additional goal will build upon the previous. The engineers must gain a knowledge in EEPROM usage. The EEPROM will allow the team to gather data that can be used to strengthen code. This will be important in making efficiently powered procedures for the AEV. Being able to create tables and graphs with the EEPROM will be another procedure that the engineers must learn. Visualization of data is an important method for dissecting information and building upon it.

The ability to apply wind tunnel data into coding will be another challenge. When testing future designs and propeller configurations, the engineers must be able to use their findings when coding. Familiarization in this area will allow the development of effective code.

Weekly Goals

1. Understand the code used on the track
2. Be able to use EEPROM data to make better code
3. Star Progress Report 4 early
4. Decide on a final design

Weekly Schedule

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Task(s)** | **Teammate** | **Start Date** | **Due Date** | **Time Needed** |
| Develop Code | Quin/Matthew | 2/2 | 2/9 | 15 minutes |
| Troubleshoot Code | All | 2/2 | 2/9 | 10 minutes |
| Operate EEPROM | All | 2/2 | 2/9 | 15 minutes |
| Analyze Data | All | 2/2 | 2/9 | 15 minutes |
| Week 3 Progress Report | All | 1/2 | 2/9 | 1.5 hours |

**Appendix A:**

Team Meeting Notes:

Meeting 2/2

Norton House @ 8:30pm

Item to be completed: Progress Report: Lab 3

Prepare for Lab 3

Table 1: 0.2510 in. diameter propellor

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Current (Amps)** | **Thrust (grams)** | **RPM** | **% Power** |  |  |
| 0.09 | 205.4 | 0 | 0 |  |  |
| 0.2 | 205.6 | 2035 | 10 |  |  |
| 0.28 | 206.6 | 3293 | 15 |  |  |
| 0.38 | 208 | 4610 | 20 |  |  |
| 0.46 | 209.8 | 5868 | 25 |  |  |
| 0.56 | 211.9 | 7065 | 30 |  |  |
| 0.61 | 213.2 | 8383 | 35 |  |  |
| 0.59 | 214.6 | 9760 | 40 |  |  |
| 0.74 | 218.4 | 10778 | 45 |  |  |
| 0.79 | 221.5 | 12035 | 50 |  |  |
| 0.83 | 224.4 | 13173 | 55 |  |  |
| 0.88 | 227.4 | 14610 | 60 |  |  |
| *Diameter: .2510 in* |  |  |  |  |  |
| **Thrust Calibration (g)** | **RPM** | **Power Input (Watts)** | **Power Output (Watts)** | **Efficiency** | **Advance Ratio** |
| 0 | 0 | 0 | 0 |  | 0 |
| 0.0882 | 2035 | 0.148 | 0.002420208 | 1.635275676 | 12.94903576 |
| 0.5292 | 3293 | 0.3108 | 0.014521248 | 4.672216216 | 8.002213107 |
| 1.1466 | 4610 | 0.5624 | 0.031462704 | 5.594364154 | 5.716114482 |
| 1.9404 | 5868 | 0.851 | 0.053244576 | 6.256706933 | 4.490676169 |
| 2.8665 | 7065 | 1.2432 | 0.07865676 | 6.326959459 | 3.729835494 |
| 3.4398 | 8383 | 1.5799 | 0.094388112 | 5.97430926 | 3.14341975 |
| 4.0572 | 9760 | 1.7464 | 0.111329568 | 6.374803481 | 2.699927025 |
| 5.733 | 10778 | 2.4642 | 0.15731352 | 6.383959094 | 2.444914433 |
| 7.1001 | 12035 | 2.923 | 0.194826744 | 6.665300855 | 2.189554446 |
| 8.379 | 13173 | 3.3781 | 0.22991976 | 6.806185726 | 2.000401409 |
| 9.702 | 14610 | 3.9072 | 0.26622288 | 6.813648649 | 1.803647349 |

Table 2: 0.3030 in. diameter propellor data

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Current (Amps)** | **Thrust (grams)** | **RPM** | **% Power** |  |  |
| 0.19 | 143.2 | 0 | 0 |  |  |
| 0.29 | 145.2 | 2275 | 10 |  |  |
| 0.37 | 147.4 | 3353 | 15 |  |  |
| 0.46 | 150.6 | 4191 | 20 |  |  |
| 0.55 | 154.2 | 5029 | 25 |  |  |
| 0.64 | 158.4 | 5808 | 30 |  |  |
| 0.74 | 163.2 | 6526 | 35 |  |  |
| 0.85 | 168.2 | 7305 | 40 |  |  |
| 0.94 | 173.6 | 7844 | 45 |  |  |
| 1.03 | 178.5 | 8622 | 50 |  |  |
| 1.13 | 185.1 | 9221 | 55 |  |  |
| 1.21 | 190 | 9760 | 60 |  |  |
| *Diameter: .3030 in* |  |  |  |  |  |
| **Thrust Calibration (g)** | **RPM** | **Power Input (Watts)** | **Power Output (Watts)** | **Efficiency** | **Advance Ratio** |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0.882 | 2275 | 0.2146 | 0.02420208 | 11.27776328 | 9.595144857 |
| 1.8522 | 3353 | 0.4107 | 0.050824368 | 12.37505917 | 6.510275738 |
| 3.2634 | 4191 | 0.6808 | 0.089547696 | 13.15330435 | 5.208531269 |
| 4.851 | 5029 | 1.0175 | 0.13311144 | 13.08220541 | 4.340615341 |
| 6.7032 | 5808 | 1.4208 | 0.183935808 | 12.94593243 | 3.758428814 |
| 8.82 | 6526 | 1.9166 | 0.2420208 | 12.6276114 | 3.344921016 |
| 11.025 | 7305 | 2.516 | 0.302526 | 12.02408585 | 2.98822102 |
| 13.4064 | 7844 | 3.1302 | 0.367871616 | 11.75233583 | 2.782885588 |
| 15.5673 | 8622 | 3.811 | 0.427166712 | 11.20878279 | 2.531773898 |
| 18.4779 | 9221 | 4.5991 | 0.507033576 | 11.02462604 | 2.367308811 |
| 20.6388 | 9760 | 5.3724 | 0.566328672 | 10.5414465 | 2.236573212 |

Arduino Code:

**Reflectance Sensor Test:**

*// Test reflectance sensors.*

*reflectanceSensorTest();*

**Inside Track:**

// Run all motors at a constant speed of 25% power for 2 seconds.

motorSpeed(4,25);

goFor(2);

// Run all motors at a constant speed of 20%, travel 13.5 feet.

motorSpeed(4,20);

goToAbsolutePosition(79);

// Reverse the motors.

reverse(4);

// Run all motors at a constant speed of 30% power for 1 second.

motorSpeed(4,30);

goFor(1);

// Brake all motors.

brake(4);

Sample calculations done for, Arduino Power setting: 50%

*Calibrated Thrust: Tc=0.411(T-T0) T* = thrust scale reading *T0* = thrust scale reading at 0%

*Tc=0.411(178.5 g-143.2 g)=14.5 g*

*Power Input:* P-in=VIP%/100

*V* = voltage (volts) *I* = current (amps) *P%* = Arduino power setting

P-in=(7.4\*1.03\*50)/100=3.81 W

*Power Output: P-out=Tcv v* = wind tunnel velocity

*P-out=14.5g\*2.8 m/s=40.6 W*

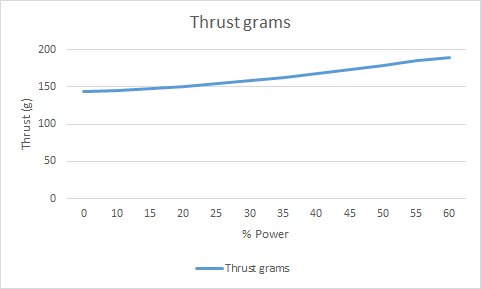
*Propulsion Efficiency: sys=(P-in/P-out)\*100 %*

*sys=(3.81W/ 40.6 W)\*100 %= 9.38%*

*Advance Ratio: J=v(RPM/60)D RPM* = propeller revolutions per minute *D* = propeller diameter

*J=2.8 m/s\*(8622/60)\*0.0077 m=3.10*

Graph 1: %power vs Thrust



Graph 2: Advance ratio vs Efficiency

