DASL UAV Antenna Gimbal

Final Product Testing Proof

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2017-2018

Summary
This report will outline testing procedures to verify all engineering requirements were met by the system. The majority of the tests are either pass or fail, with no room for tolerances. Each test is described in the following subsections.

Size:
The overall surface area of the system mounting to the UAV is less than 15 in^2 in order to fit on the UAV base plate provided by the DASL. This requirement was tested by measuring the surface area of the system that attaches directly to the UAV, such as the top of the mounts. This area is measured with calipers from the Rapid Lab and calculated using the geometry of the shape of the mounts. The surface area of each part is displayed in Table 1. The total area is 4.8405 in^2, which is less than 15 in^2; therefore the design passed the size requirement test. See Appendix A for figures displaying width and length of parts.

Table 1: Surface Area of Parts

Part	Surface Area (in^2)	Quantity of Parts	Total Surface Area (in^2)
Mounting Bracket	0.5047	6	3.0281
Motor Mount	0.6044	1	0.6044
Arduino Mini Pro	1.2080	1	1.2080
Total Surface Area of Device (in^2)			4.8405

Gimbal Weight:
To test the weight requirement, the system was weighed with two scales provided by the Rapid Lab. All components of the device were placed on the small scale individually to measure the weight of the parts. To ensure these measurements were accurate, the team also placed all the parts on a larger scale at once to compare to the additive weight of each part. The additive weight totaled at 0.4086 lbs, and the collective weight was 0.40 lbs. The difference in these weights could be explained by the difference in tolerances of the scales used. The total weight of the device fitted within the allotted requirement of 0.5 lbs. Each weight is listed in Table 2, and photos can be referenced in Figures B1-B11.

Table 2:

Part	Weight (lbs)	Quantity of Parts	Total Part Weight (lbs)
Mounting Bracket	0.0077	6	0.0462
Motor Mount	0.0104	1	0.0104
Cam Arm 1	0.0140	1	0.0140

Cam Arm 2	0.0137	1	0.0137
Pivot Base	0.0032	4	0.0128
10-32 Screws	0.0051	14	0.0714
10-32 Nuts	0.0024	16	0.0384
M-5 Screws	0.0047	2	0.0094
Arduino Pro Mini (and wires)	0.0134	1	0.0134
Servo Motor	0.1789	1	0.1789
		Total Weight of Device (lbs)	0.4086

Angle of Travel:

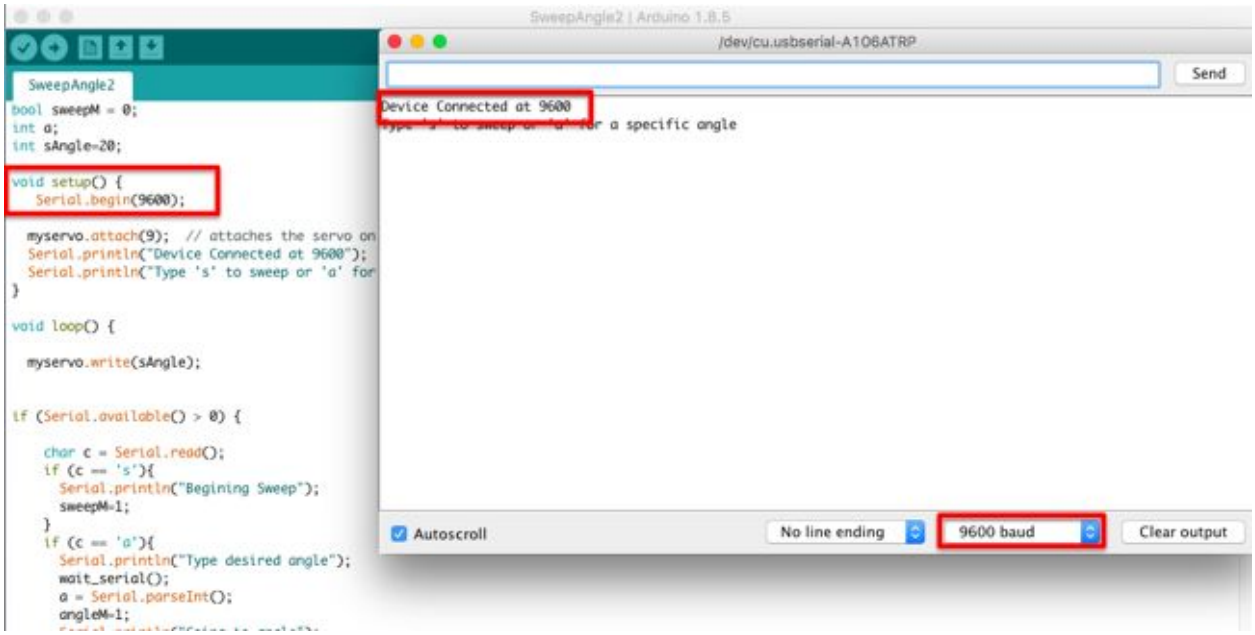
The angle of travel meets the ability to go from 0° (horizontal) to 45° below horizontal. It is measured using the angle reported by the system and approximated with a protractor and by eye to ensure a correct reading from the system.

Modes of Rotation:

The device was tested for both stepping modes and continuous motion. The team ran a program, telling the motor to go to either move to a specific angle, or continuously sweep from 0° to 45°. The motor was then installed into the system and tested with all components to ensure correct function inside the UAV assembly. The system was capable of moving the antenna to a specified angle as well as through the entire angle range continuously, therefore the requirement was met. This test was conducted without measurement tools, as it was observed by watching the movements.

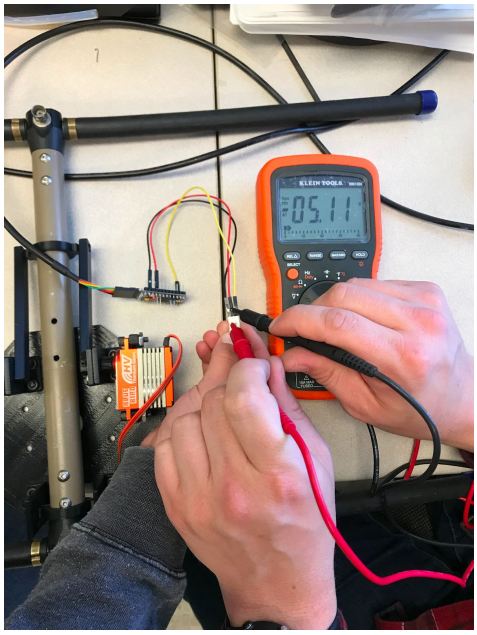
Serial Communication:

To allow communication between the Arduino Pro Mini and UAV, the system must operate at the same baud rate. The team was given a specified baud rate of 9600 that should allow the Arduino Pro Mini and Raspberry Pi to communicate. To test the baud rate, the team first sets the serial communication in the Arduino code. Then, with the device connected, and serial monitor open, the team was able to confirm a baud rate of 9600 as seen in figure___.



Power Input:

The power input test was conducted using a digital multimeter (DMM) provided by the Rapid Lab to measure the voltage required to operate the device. The team's device must be run on 5 ± 0.5 V. This is the amount of volts the DASL UAV can supply to the device during flight. The DMM was used to measure the voltage being consumed by the system in a paused operational state. The total voltage being consumed by the system is 5.11 V as seen in the DMM in Figure __.

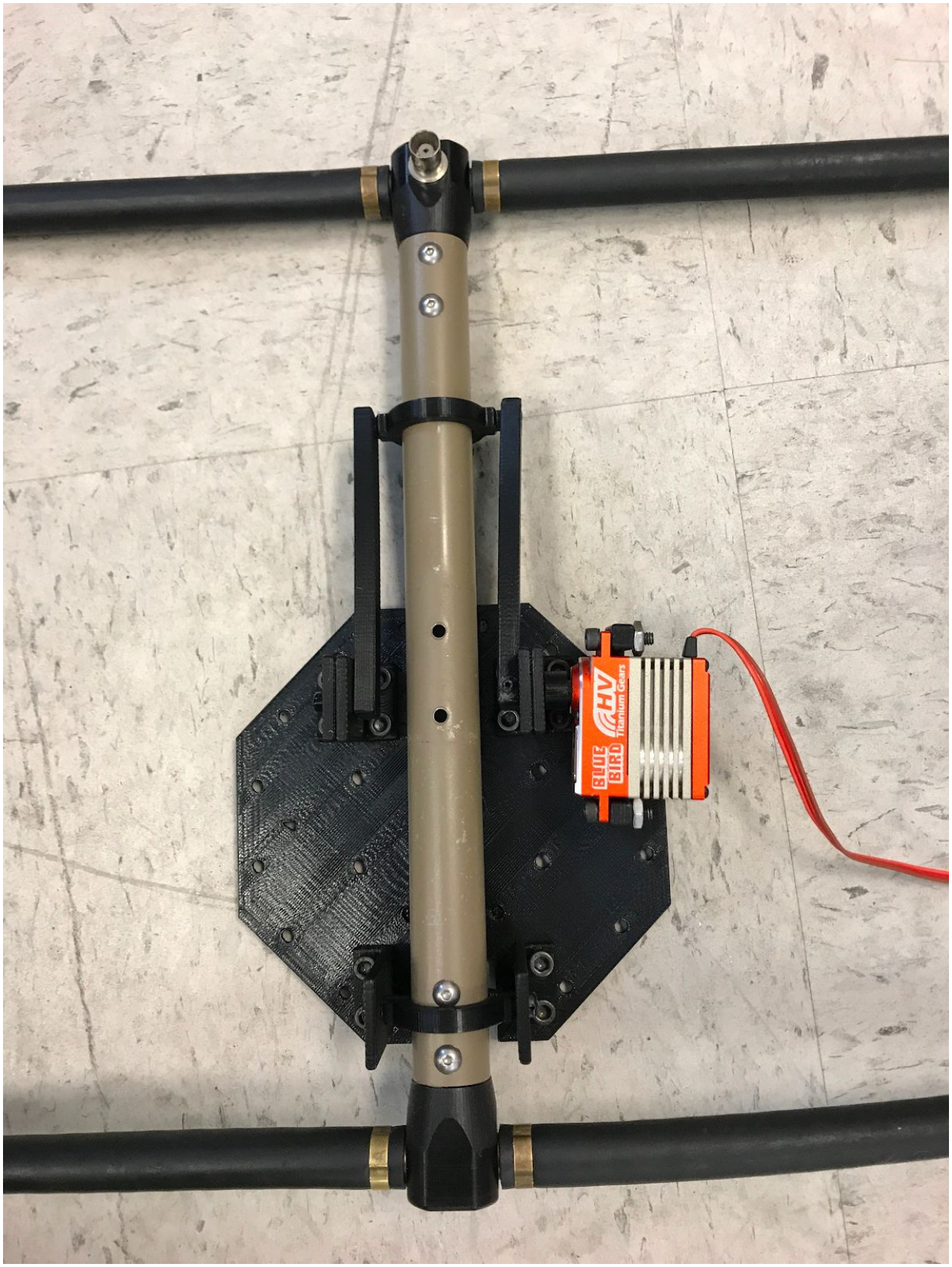


Cost:

All costs for components and services did not exceed the budget of $500. This requirement was tested by adding the total cost of components for the gimbal system. The total budget, as seen in Table ___ is ___, which is less than $500; therefore the requirement is met.

Linkages:

The total number of moving components did not exceed 4. This requirement was tested by counting the number of linkages present in the design. There were no special tools or equipment required to measure this specification.


BLUE BIRD
HV
Titanium Gears

Part Installation Time:

Part installation time must be under 1 hour. If one part is broken, it must be able to be fixed in under 1 hour. To ensure any part can be fixed in the alloted time, the team conducted multiple trials of replacing the entire system. This was done using an iPhone timer with a resolution of 0.01s. The team conducted 3 trials for this test, timing the disassembly and assembly of the system. The largest time trial for this test was 22:36 minutes, and the average time was __. Since entire system can be replaced in well under one hour, any part of the system can be replaced in the alloted hour per the teams requirement.

Trial	Disassembly Time (min:sec)	Assembly Time (min:sec)	Total Time (min:sec)
1	4:09	18:27	22:36
2	7:30	7:47	15:17
3	2:17	11:33	13:50
Average	4:39	12:31	17:14

Appendix A: Size Testing

Figure A.1: Width of Mounting Bracket

Figure A.2: Length of Mounting Bracket

Figure A.3: Width of Motor Mount

Figure A.4: Length of Motor Mount

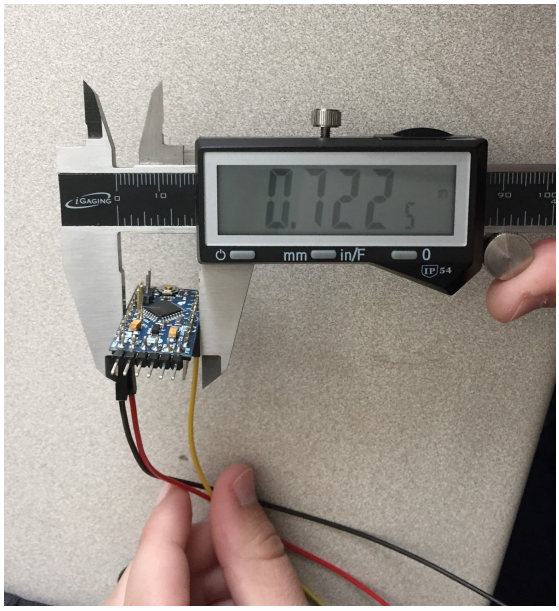


Figure A.5: Width of Arduino

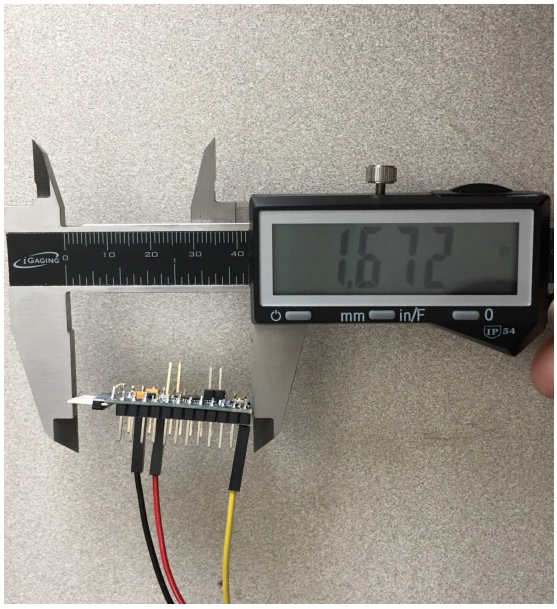


Figure A.6: Length of Arduino

Appendix B: Weight Testing

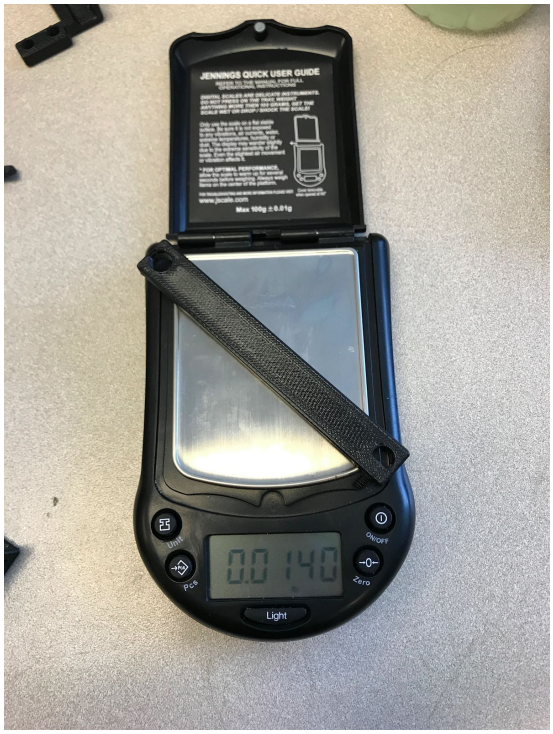


Figure B1: Cam Arm 1 Weight

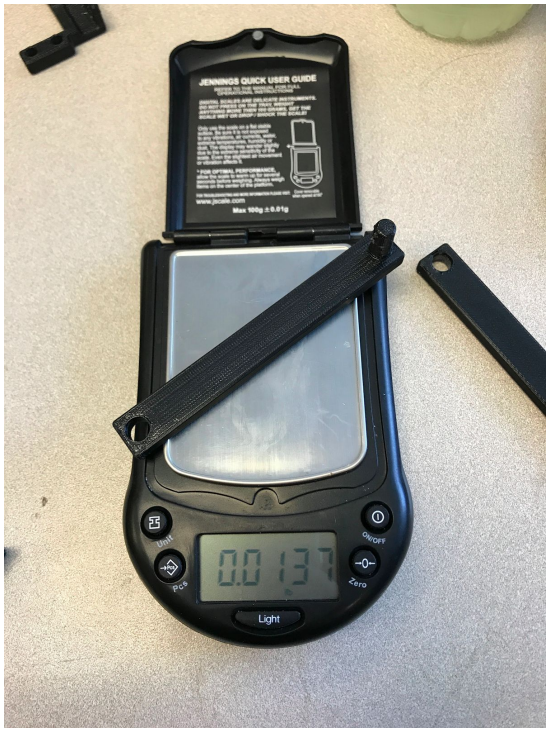


Figure B2: Cam Arm 2 Weight

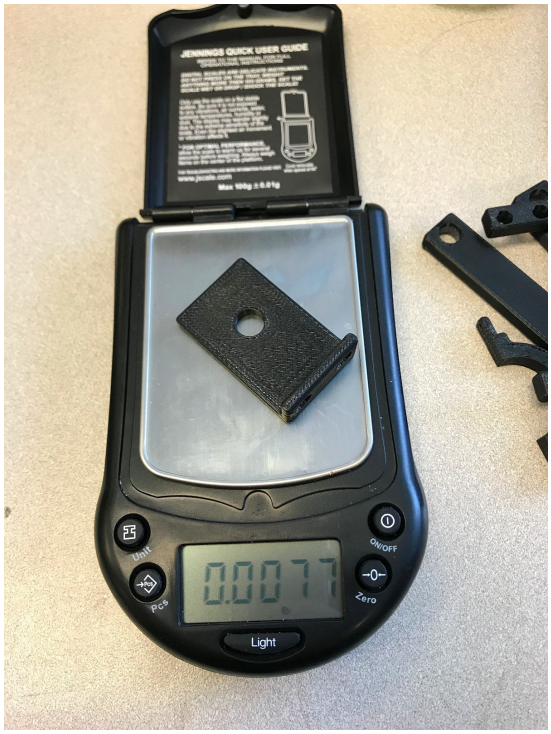


Figure B3: Mounting Bracket Weight

Figure B4: Motor Mount Weight

Figure B5: Pivot Base Weight

Figure B6: Nut Weight

Figure B7: 10-32 Screw Weight

Figure B8: M-5 Screw Weight

Figure B9: Servo Motor Weight

Figure B10: Arduino Pro Mini Weight

Figure B11: Combined Part Weight