DASL UAV Antenna Gimbal

Team D1:
Kalli Albright
Kaitlyn Barr
Dustin Branges
Daniel Johnson

March 13th, 2018

Project Description: Review

- Dynamic and Active Systems Lab (DASL) at Northern Arizona University (NAU)
- Unmanned Aerial Vehicle to track wildlife
  - Very High Frequency (VHF) Telemetry
  - Telonics RA-23K Antenna
- Create antenna gimbal to more efficiently collect data
- Goal: make the tracking of wildlife less invasive and easier than before

Project Description: Previous Designs

Initial Design

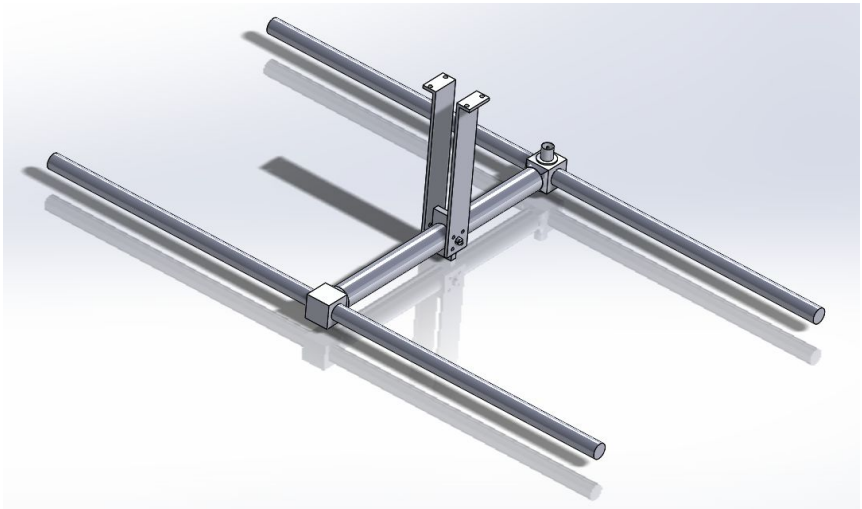


Figure 1: Initial Gimbal Design

Redesign

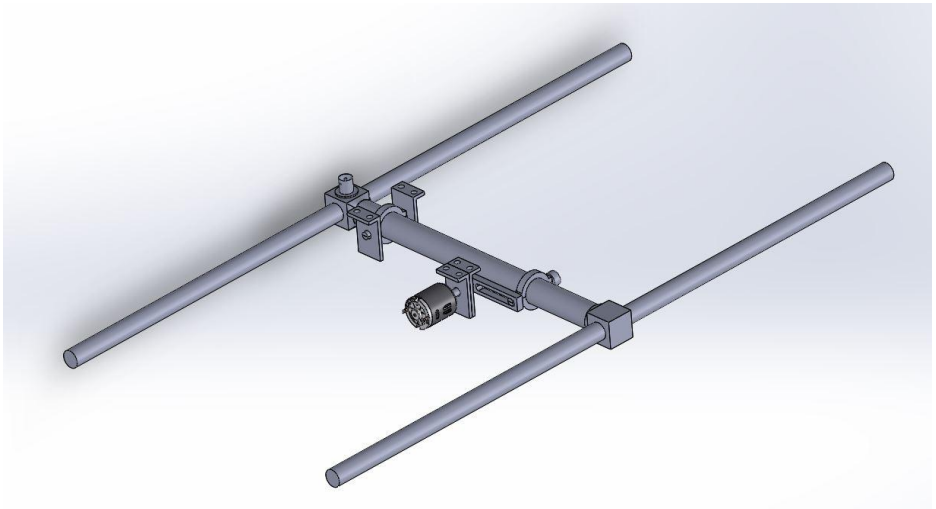


Figure 2: Second Iteration Gimbal Design

Project Description: Current Manufactured Design

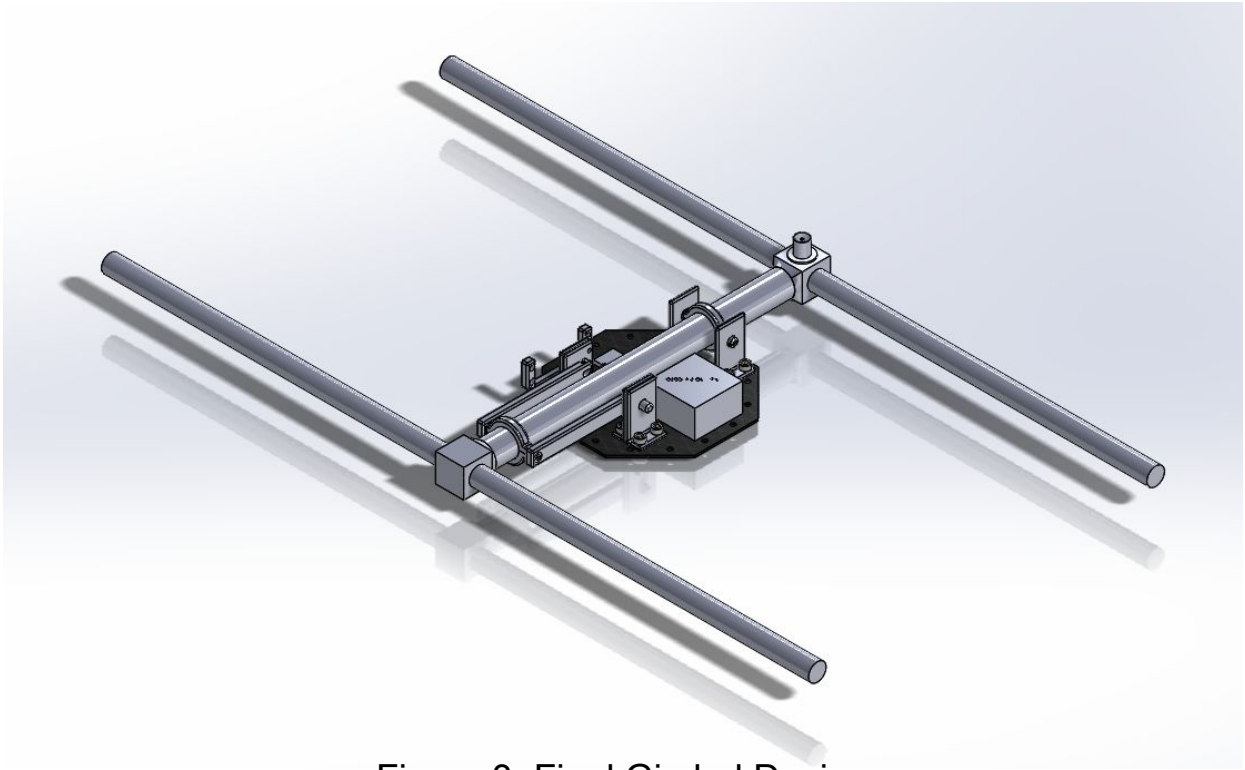


Figure 3: Final Gimbal Design

Project Description: Current Manufactured Design

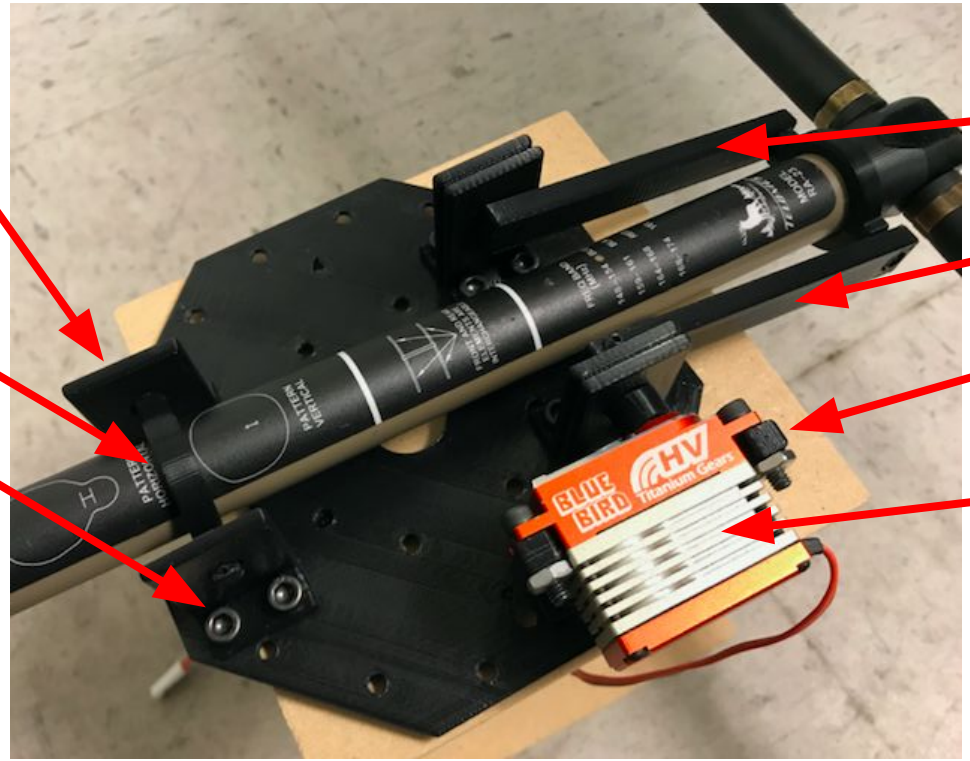


Figure 4: Final Gimbal Design

Updates: Summary

- Motor
- Pivot Base
- Mounting Brackets
- Dual Cam Arm

Updates: Motor

Table 1: Servo Comparison

	Old Servo	**New Servo**
Motor Name	Hitec HS-81	Bluebird
Dimensions (in.)	1.17 x 0.47 x 1.16	1.59 x 0.79 x 1.54
Weight (lb.)	0.04	0.18
Torque at 6V (in*lb)	2.34	25.2
Picture		

Updates: Pivot Base Mobility

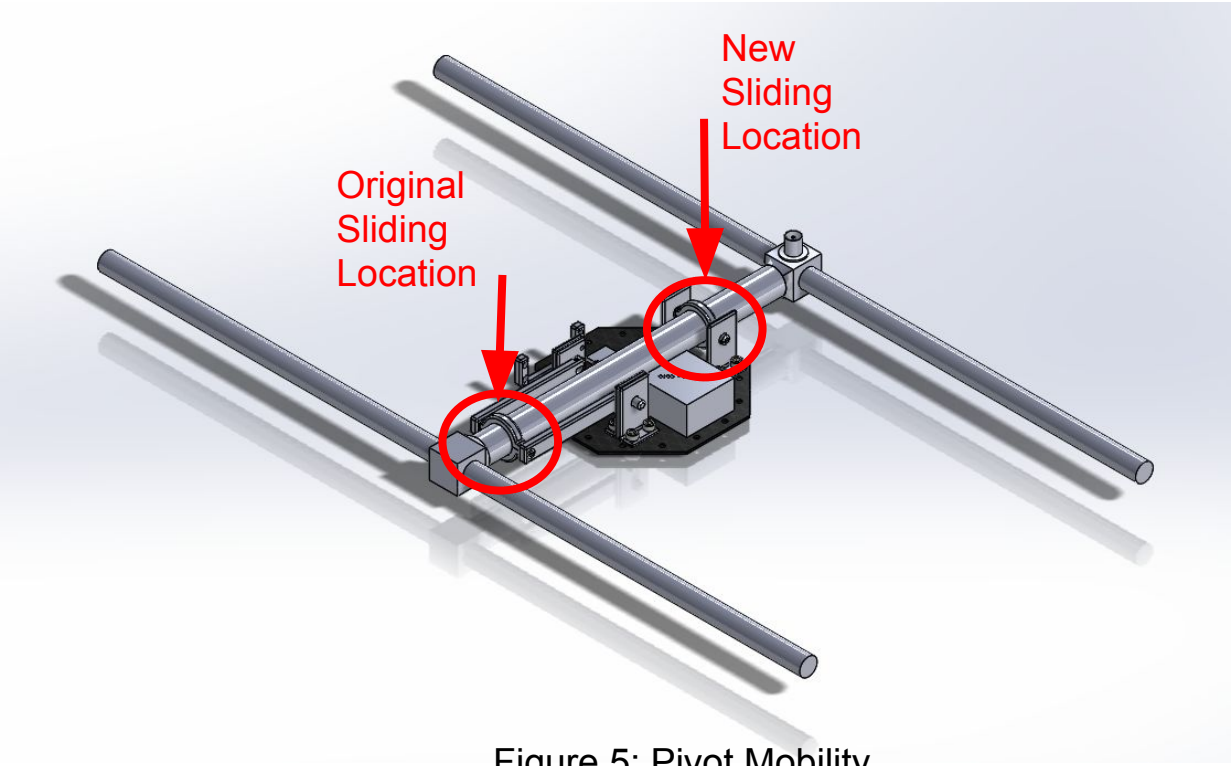


Figure 5: Pivot Mobility

Updates: Mounting Brackets

- Deleted stopper
- Deleted mounting holes for old motor
- Added fillets

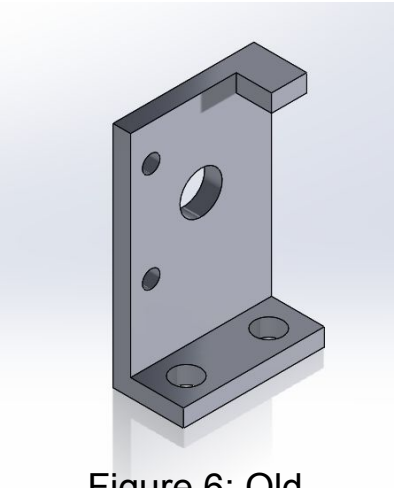


Figure 6: Old Mounting Bracket

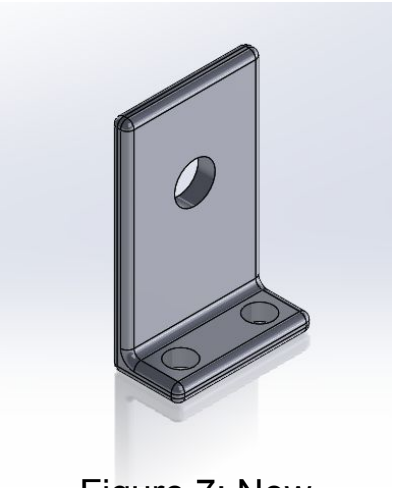


Figure 7: New Mounting Bracket

Updates: Dual Cam Arms

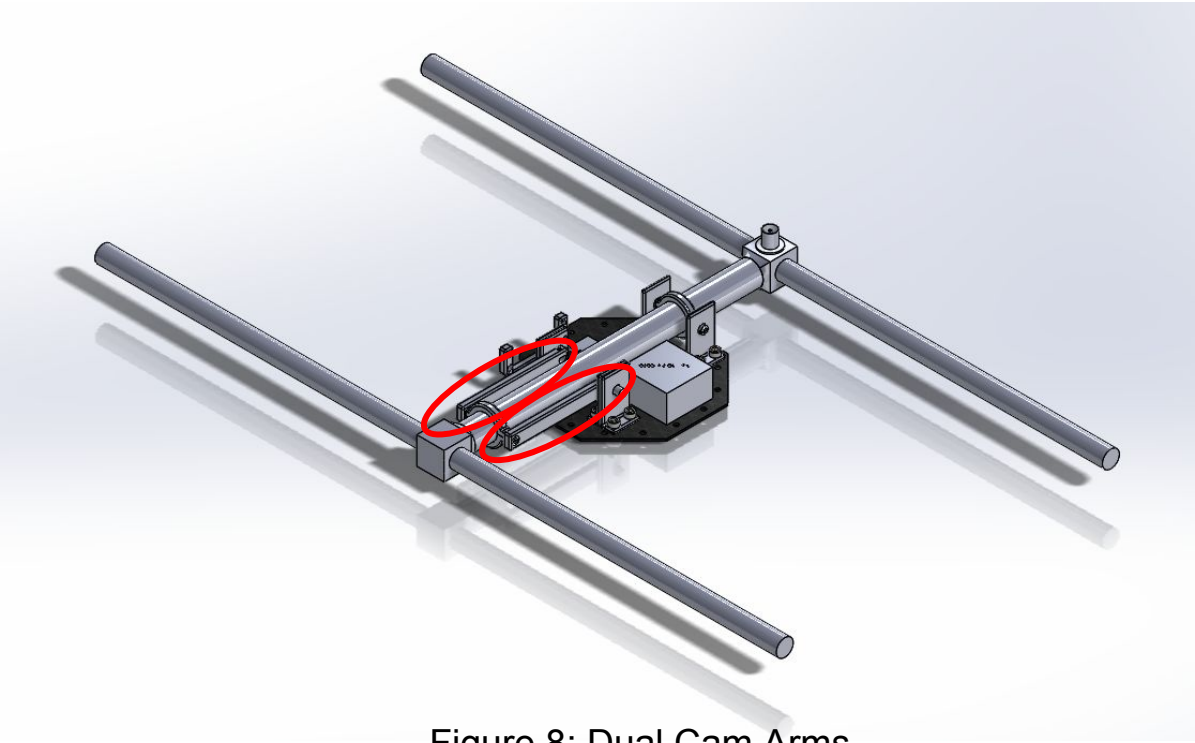
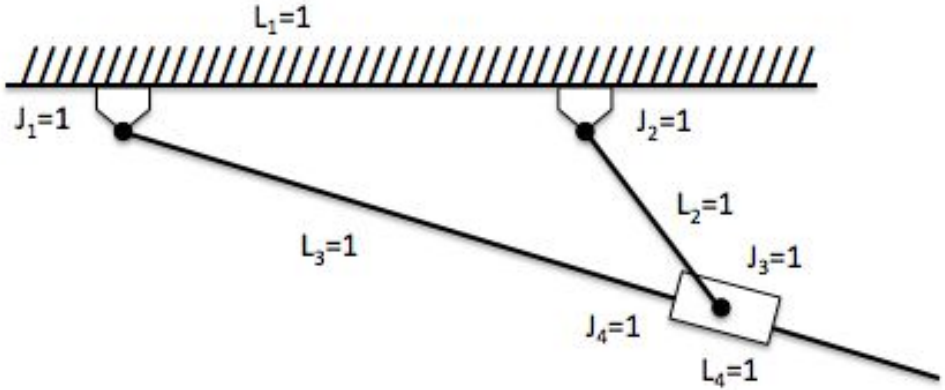


Figure 8: Dual Cam Arms

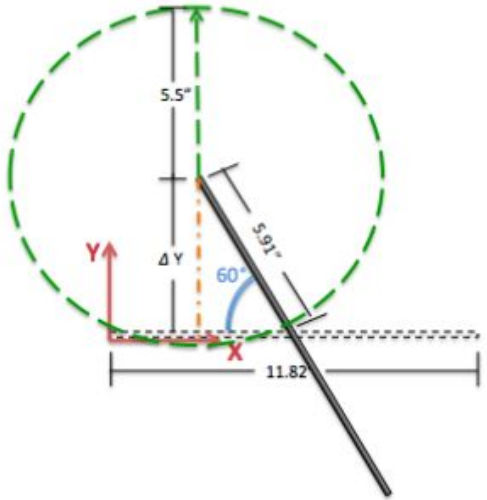
Updates: Analytical Analysis - Linkage Mobility

- Assuming all linkages are rigid bodies
- Gruebler's Equation
  - M = 3(L-1) - 2J
  - M: mobility or degrees of freedom
- Result
  - M=1 : mechanism
  - Needs single input motion

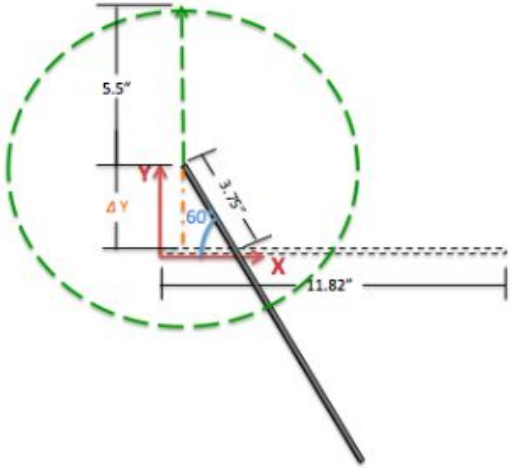


Updates: Analytical Analysis - Antenna Rotation Point

- High antenna deflection
- Must avoid interference with rotors
- Changing the rotation location changes the safe height difference

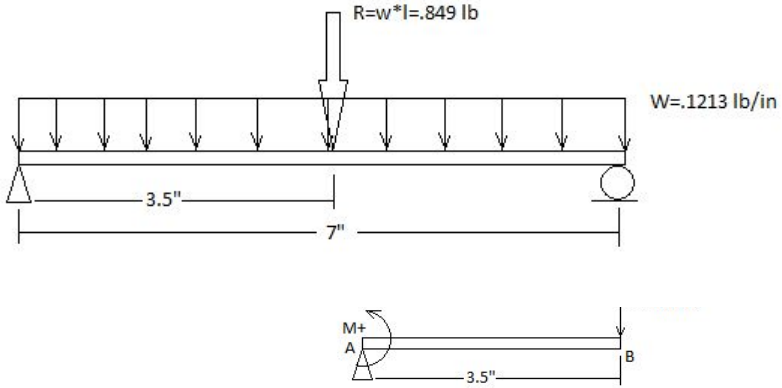


$\Delta Y_{center} = 10.62\ in.$



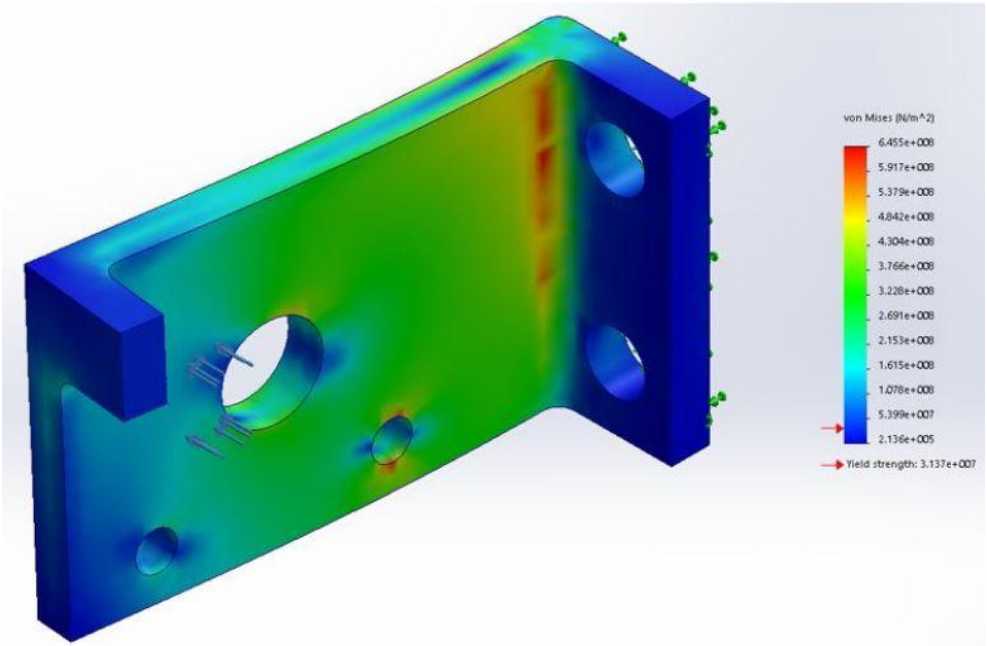
$\Delta Y_{3.75} = 8.75\ in.$

Updates: Analytical Analysis - Motor Torque



- Used sum of forces for first diagram
- Solved for reactions
- Applied reaction force at B on diagram 2
- Used sum of moments at A to solve for minimum torque
- Minimum required torque is 1.486 in-lbs (approximately 1.5 in-lbs)

Updates: Analytical Analysis - Von Mises Stress



- Based on:
  - 572.9N caused by impact
  - 3 foot drop height
  - Stratasys ABS-M30 properties
  - Entire force localized to a small area on a single part
  - “Worst case scenario”
- Max stress: $6.455*10^8$ N/m^2
- Material ultimate tensile strength: $3.206*10^7$ N/m^2

Moving Forward: Manufacturing Plans

- Done
  - Printed all parts in ABS on Fortus 250MC
  - Gather fasteners from Machine Shop
  - Gather Arduino, Servo, and other accessories from Amazon
  - Assemble all parts

- To Do
  - Print replacement parts
  - Calibrate angle

Moving Forward: Testing

Test	Procedure	Requirement
Size	Measure surface area of system with ruler	≤ 15 $in.^2$
Weight	Weigh all components of the system with scale	≤ 0.5 lbs.
Angle	Measure maximum angle with protractor	$\geq 45^0$
Modes	Note the number of user modes	≥ 2
Communication	Note the rate of serial communication	= 9600 Baud
Power Input	Measure power input with multimeter	≤ 5 V
Cost	Calculate total cost	≤ $500
Linkages	Count number of linkages	≤ 4
Installation Time	Using stop watch, time how long it takes to fully assemble	≤ 1 hour

Moving Forward: Budget Changes

- Changes
  - Added testing materials ~$15
  - Motor changed $14.50 -> $66.89
- Initial budget- $125.89
- Final budget- $193.89

Vendor	Purpose	Part #	Part Name	Part No.	Dimensions	Material	Cost ($/part)	Quantity	Total ($)	
Amazon	Parts & Material	11	Blue Bird 7.4V Servo	BMS-35A	N/A	N/A	66.89	1	66.89	Y
		12	Aideepen L298N DC Drive Controller	100752	1.69" x 1.69" x 1"	N/A	6.99	1	6.99	Y
		13	Velcro	N/A	N/A	N/A	2.98	1	4.29	Y
	Fabrication	14	Acetone	N/A	N/A	N/A	5.95	1	5.95	Y
								Total ($)	84.12	
Vendor	Purpose	Part #	Part Name	Part No.	Dimensions	Material	Cost ($/part)	Quantity	Total ($)	
Home Depot	Testing	24	Mock Antenna	RA 23-K	12"	Anodized Aluminum	0	1	0	Y
		25	Testing Stand Plates	N/A	5" x 5"	MDF	3.83	1	3.83	Y
		26	Testing Stand Screws	N/A		MDF	2.49	2	4.98	Y
Michaels		27	Testing Stand Blocks	N/A	4"	MDF	5.49	1	5.49	Y
								Total ($)	14.3	
							Project Total ($)		193.89	

Moving Forward: Budget

Budget Available	+$500.00
Final Design Expenses	-$193.89
Initial Design Expenses	-$14.50
Anticipated Expenses	-$0.00
Resulting Balance	**+$291.61**

Moving Forward: Gantt Chart

		Week 10			Week 11			Week 12			Week 13			Week 14			Week 15		
Task	**Leading Member**	**3/26**	**3/28**	**3/30**	**4/2**	**4/4**	**4/6**	**4/9**	**4/11**	**4/13**	**4/16**	**4/18**	**4/20**	**4/23**	**4/25**	**4/27**	**4/30**	**5/2**	**5/4**
Peer Evaluation	All																		
Website Check	Dustin Branges	3 hours																	
Continue Build Work	All	Finish Build- 10 hours																	
Poster Work Draft	Kalli Albright	10 hours																	
Operations Manual Draft	Daniel Johnson	7 hours																	
Final Product Testing Proof	Kalli Albright				15 hours														
Poster Work	Kaitlyn Barr				15 hours														
Operations Manual	Dustin Branges				15 hours														
Final CAD Package	Daniel Johnson										20 hours								
Final Report	Kaitlyn Barr										20 hours								
Website Check	Dustin Branges															3 hours			
Peer Evaluation	All																		

Hardware Review 2: Working Model

Operations:

- 2 sweeps
- Hold angle
- Sweep

Hardware Review 2: Subsystems

- Frame
  - 3D printed parts - original
  - Fasteners - existing
  - Servo Motor Blue Bird BMS35A - existing

- Software
  - Code - original
  - Arduino & accessories- existing

Hardware Review 2: How it Works

1. User inputs desired mode
2. Arduino translates code to motor
3. Motor rotates cam arm to corresponding angle
4. Cam arm supports antenna
5. System simultaneously holds opposite end of antenna

Questions?