UAV Antenna Pitching Mechanism

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Overview

- Background
- Project Goal
- Problem Statement
- Requirements
- Design Process
- Final Product
- Testing
- Conclusion

Technology of Wildlife Tracking

- Ways to track animals
  - Very High Frequency (VHF) Radio Telemetry
    - Low cost - time intensive
  - Global Positioning System (GPS)
    - High cost - more accurate

Figure 1: VHF Collar [1]

Figure 2: VHF Antenna [1]

Project Goal

- Dynamic and Active Systems Lab (DASL)
  - Lead by: Michael Shafer
  - Located at: Northern Arizona University (NAU)
- Mount a directional VHF antenna on a Unmanned Aerial Vehicle (UAV)
  - Decrease tracking cost
  - Decrease tracking time
  - Increase tracking efficiency
  - Less Intrusive

Figure 3: DASL UAV [2]

Problem Statement

- RA-23K VHF antenna
- High gain directional radiation reception pattern
- Objective: Pitch the antenna

Figure 4: RA-23K Antenna [3]

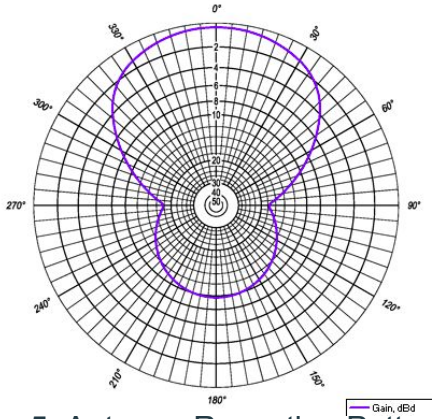
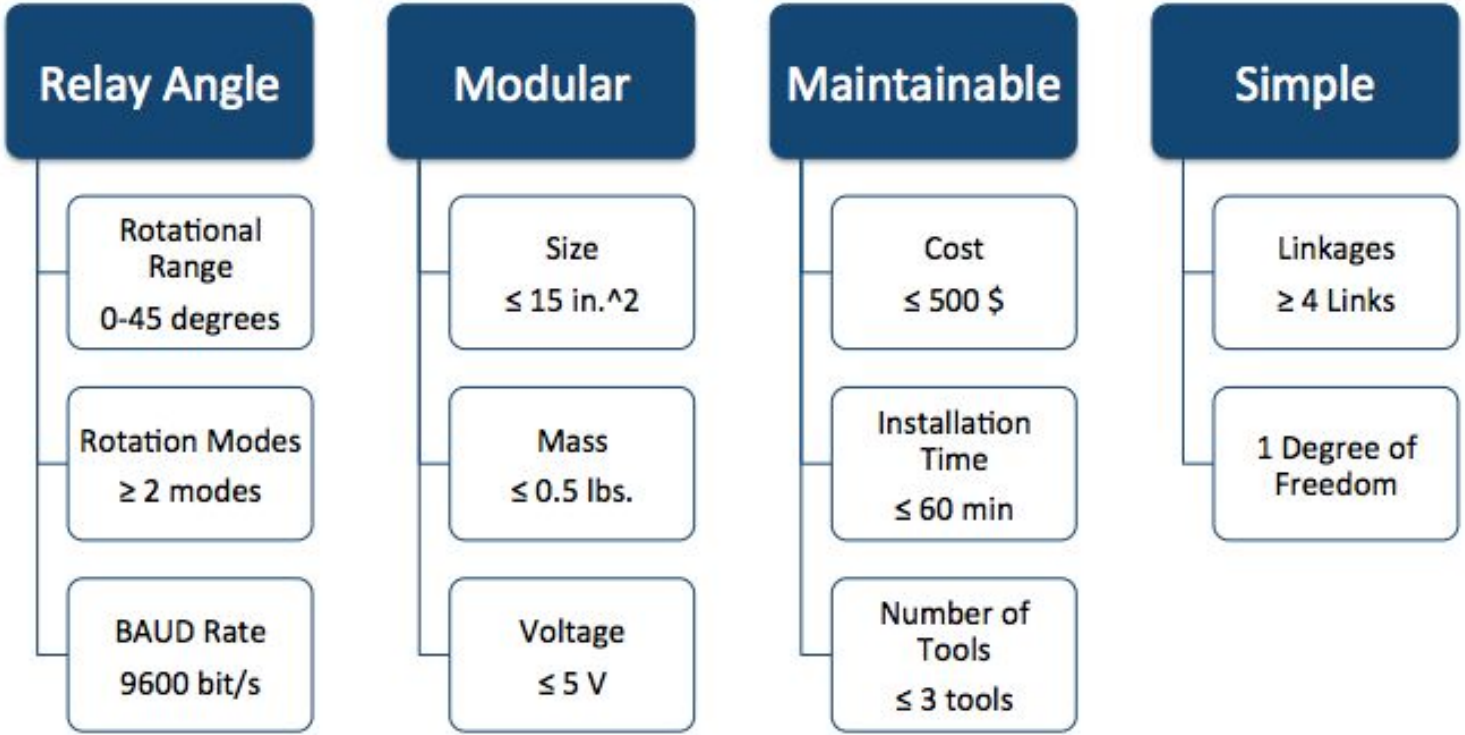


Figure 5: Antenna Reception Pattern [3]

Requirements



Designs Considered

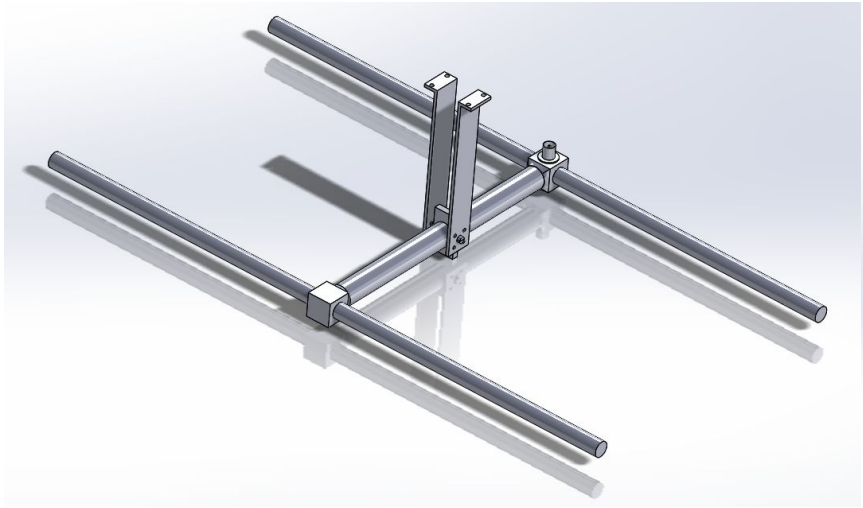


Figure 6: First Antenna Pitching Mechanism

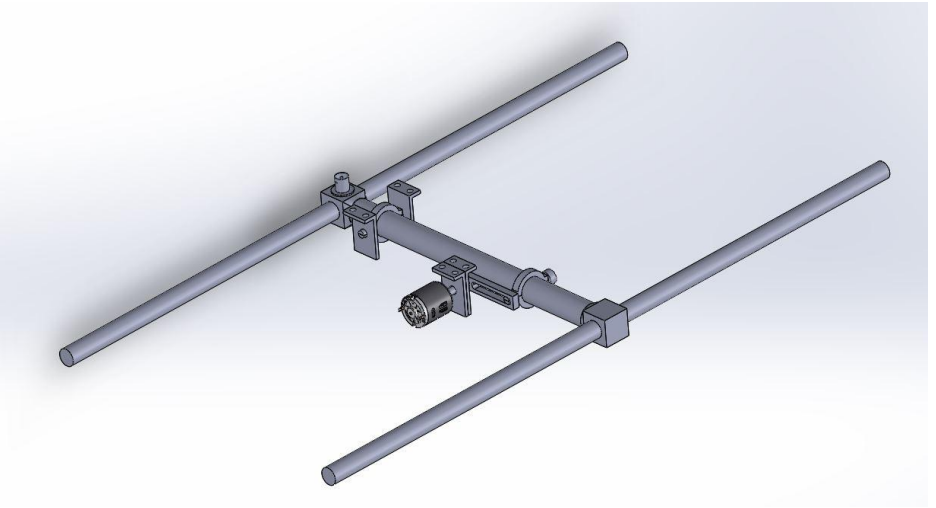


Figure 7: Second Antenna Pitching Mechanism

Chosen Design Prototype

Design Prototype:

- 2 points of connection
- Small servo
- Linkage system
- Dual Cam arms

Need for Improvement:

- Higher torque servo
- Unify mounts
- Change in sliding location

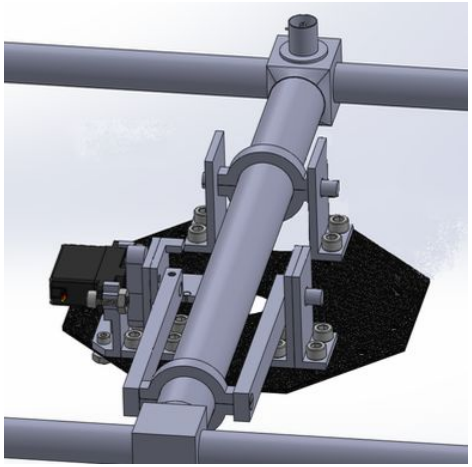


Figure 8: Third Antenna Pitching Mechanism CAD

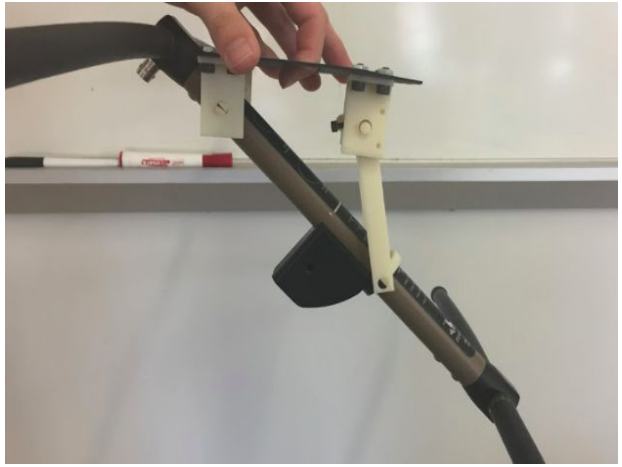


Figure 9: Product Prototype

Final Design

Updates:

- New servo motor
- Enlarged motor mount
- Unified mounting brackets
- Added fillets to all parts
- New sliding joint

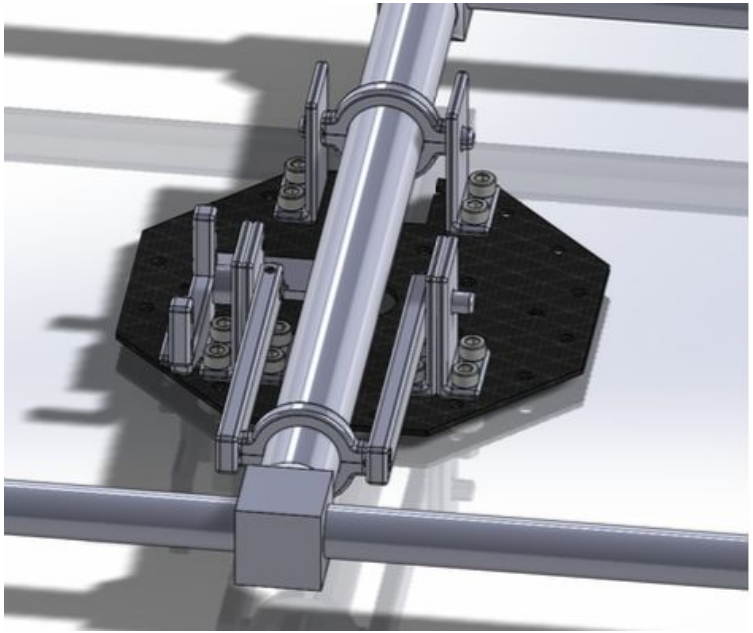


Figure 10: Final CAD

Final Design

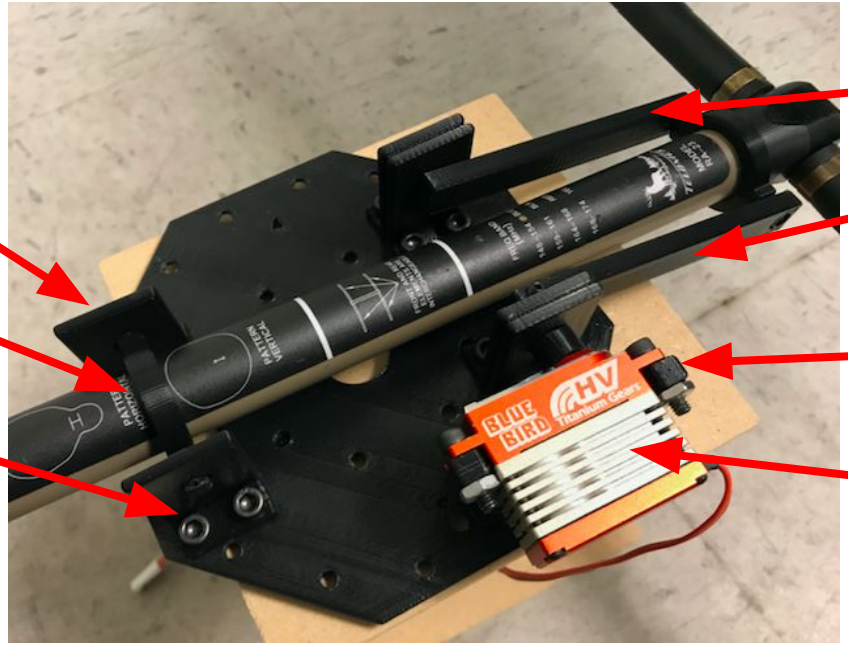


Figure 11: Completed System

Working System

Operations:

- 2 sweeps
- Hold angle
- Sweep

Video 1: Working System

Manufacturing

- Must meet maintainable requirement
  - Easily Replaceable parts:
    - 3D Printed on Fortus 250 MC
  - Assemble with 3 tools or less:
    - 1/16th Allen Wrench
    - 5/16th Wrench
    - Needle Nose Pliers

Figure 12: Fortus 250MC

Figure 13: Allen Wrench

Figure 14: Wrench

Figure 15: Pliers

Testing

Major Tests Performed:

- Surface area
- Mass
- Voltage
- Installation Times
- Rotational Range

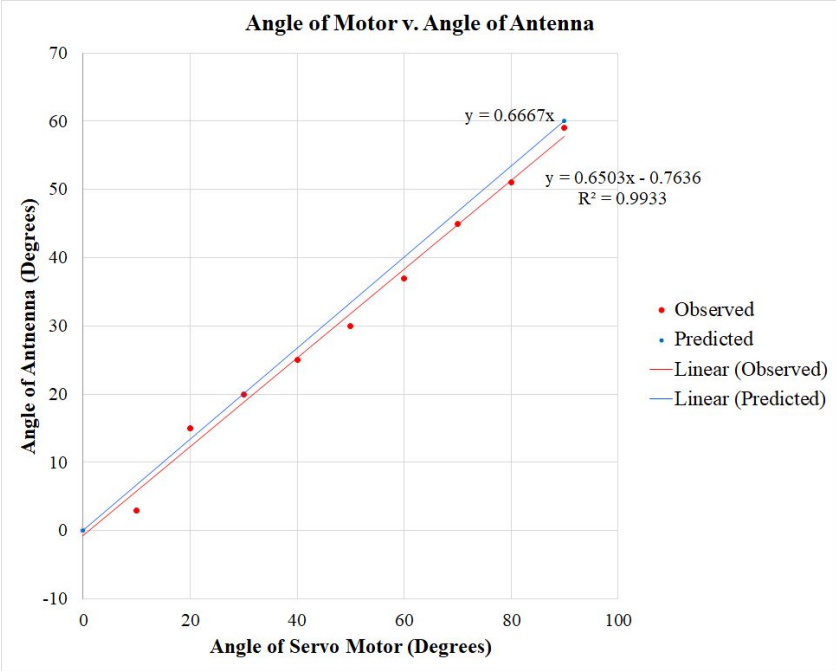


Figure 16: Angle of Motor v. Angle of Antenna

Final Budget

Table 1: Budget Distribution

Category	Cost
Programming	$92.38
Servo Motor	$66.89
Fasteners	$15.82
Printed Parts	$4.50
Testing	$14.30
Total	$193.89

Conclusion

Table 2: Requirements and Results

Engineering Requirement	Target	Final Product
Rotational Range	$\geq 45^0$	60^0
Modes	≥ 2 modes	2 modes
Communication	9600 bit/s	9600 bit/s
Surface Area	≤ 15 in^2	4.84 in^2
Mass	≤ 0.5 lbs.	0.41 lbs.
Voltage	≤ 5 V	5.11 V
Cost	≤ $500	$193.89
Installation Time	≤ 60 min	17.25 min
Number of Tools	≤ 3 tools	3 tools
Linkages	≤ 4 links	3 links

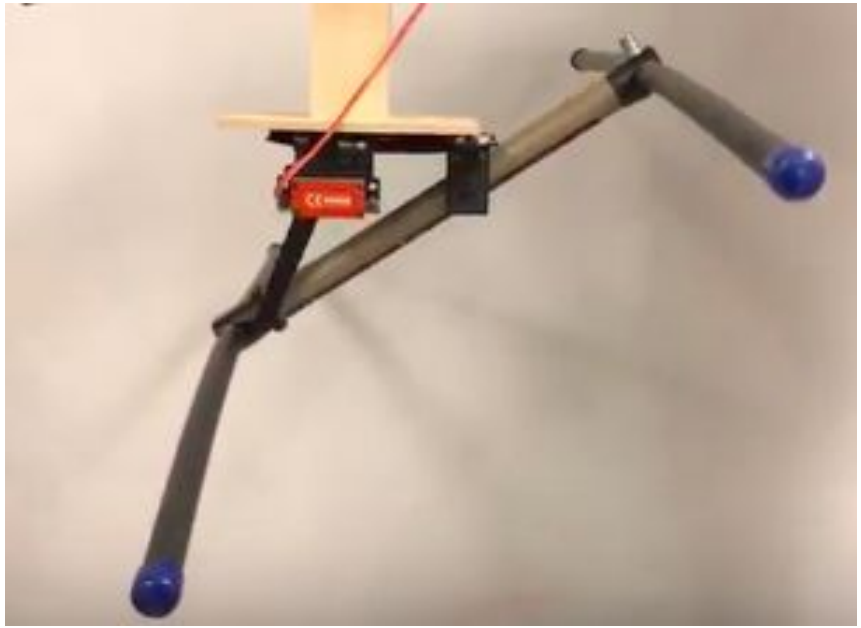


Figure 17: Final Antenna Pitching Mechanism

Questions?

Acknowledgements:

Dynamic and Active Systems Lab

National Science Foundation

Northern Arizona University

References

[1] “Wildlife Tracking and Monitoring.” *Wildlife ACT*, 26 Oct. 2017, wildlifeact.com/about-wildlife-act/wildlife-tracking-and-monitoring/.

[2] “UAV Radio Telemetry.” *Dynamic and Active Systems Laboratory*, 27 June 2017, www.cefns.nau.edu/Groups/dasl/.

[3] “RA-23K VHF Antenna.” *Telonics Inc.*, 8 Mar. 2017, www.telonics.com/products/vhfAntennas/RA-23K.php