

Directional Antenna Alignment Control System

November 16, 2020

Sea Scanners Team

Overview

- Purpose
- Requirements
- Design
- Looking Forward

Background

- Navy Has a Barge that Conducts Tests
- Test Data Sent On Shore Via Directional Antenna
- Directional Antenna is Manually Oriented



Purpose

- Design control system to remotely align antenna
- Switch for power on/off will be in convenient location
- Increased precision in antenna orientation

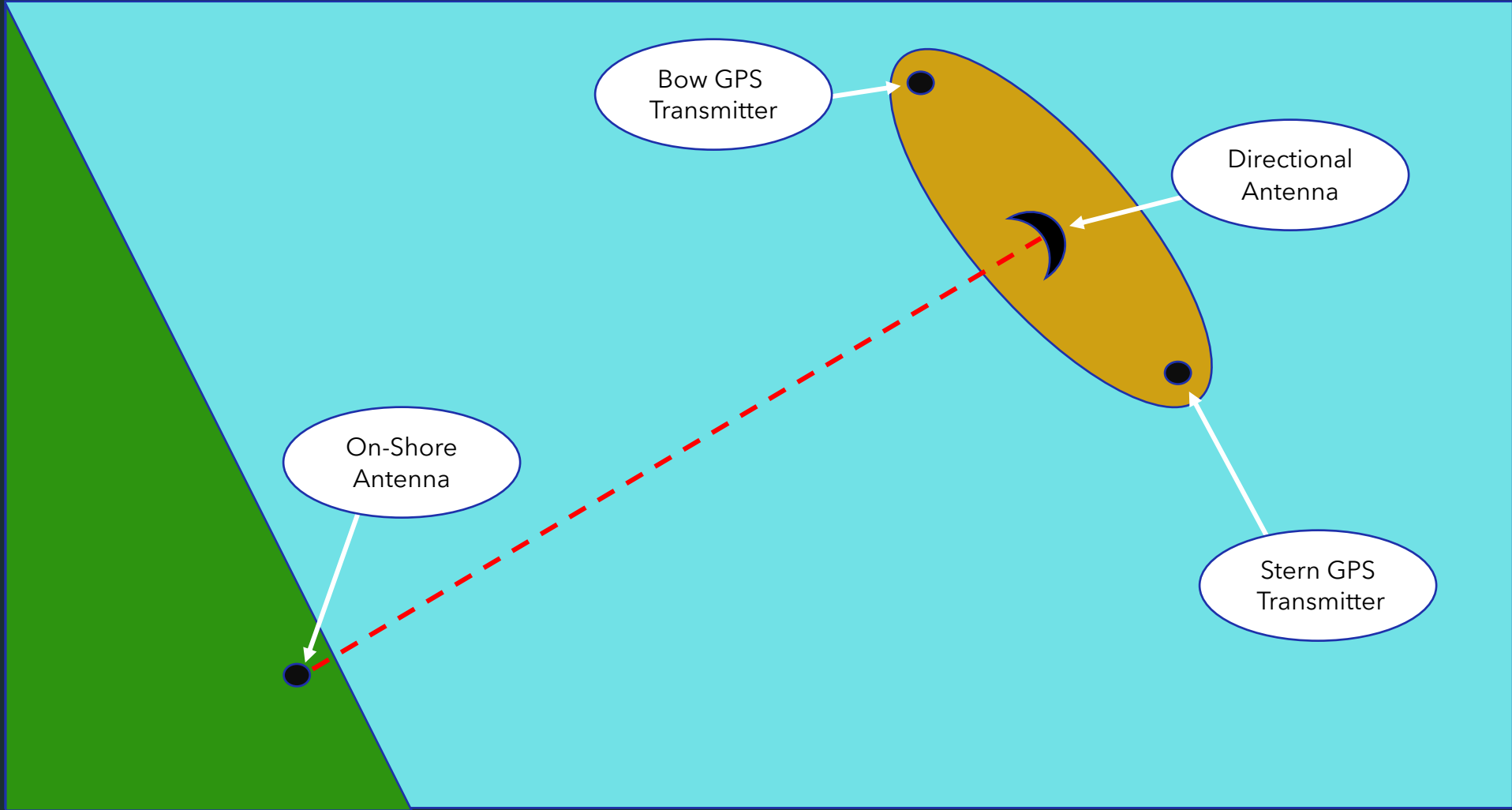


Requirements

- https://vandalsuidaho-my.sharepoint.com/:x:/r/personal/haen3244_vandals_uidaho_edu/Documents/Sea%20Scanners/Team%20Documents/Capstone%20Documents/Product%20Requirement%20Document.xlsx?d=w9c18bb0f71be432480564086c678f674&csf=1&web=1&e=lo2Yjn



Design Solution



GPS

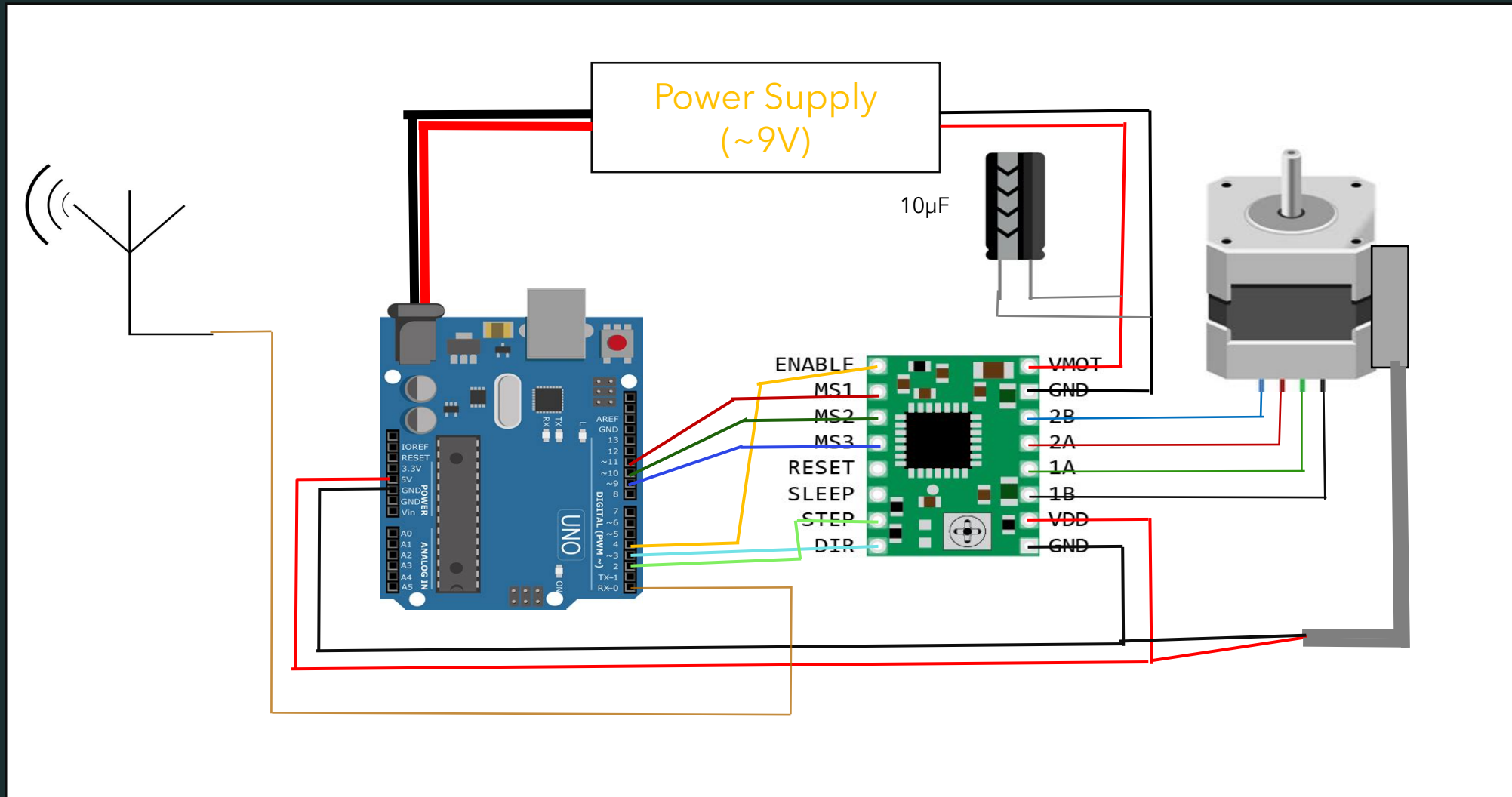
NMEA GGS messages

```
eg3. $GPGGA,hhmmss.ss,1111.11,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh
1    = UTC of Position
2    = Latitude
3    = N or S
4    = Longitude
5    = E or W
6    = GPS quality indicator (0=invalid; 1=GPS fix; 2=Diff. GPS fix)
7    = Number of satellites in use [not those in view]
8    = Horizontal dilution of position
9    = Antenna altitude above/below mean sea level (geoid)
10   = Meters (Antenna height unit)
11   = Geoidal separation (Diff. between WGS-84 earth ellipsoid and
      = mean sea level. -=geoid is below WGS-84 ellipsoid)
12   = Meters (Units of geoidal separation)
13   = Age in seconds since last update from diff. reference station
14   = Diff. reference station ID#
15   = Checksum
```

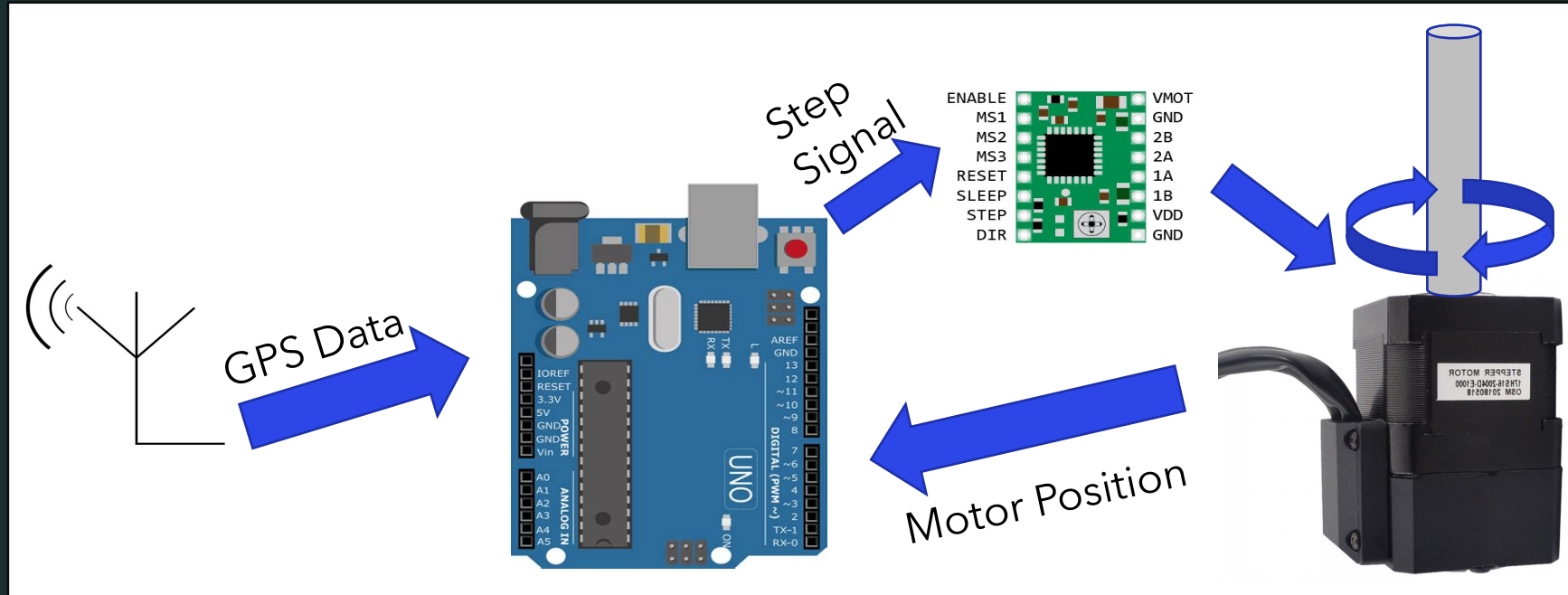



Control System

Control System Diagram



Control System Diagram



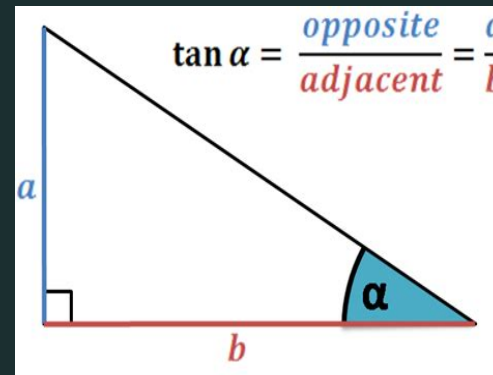
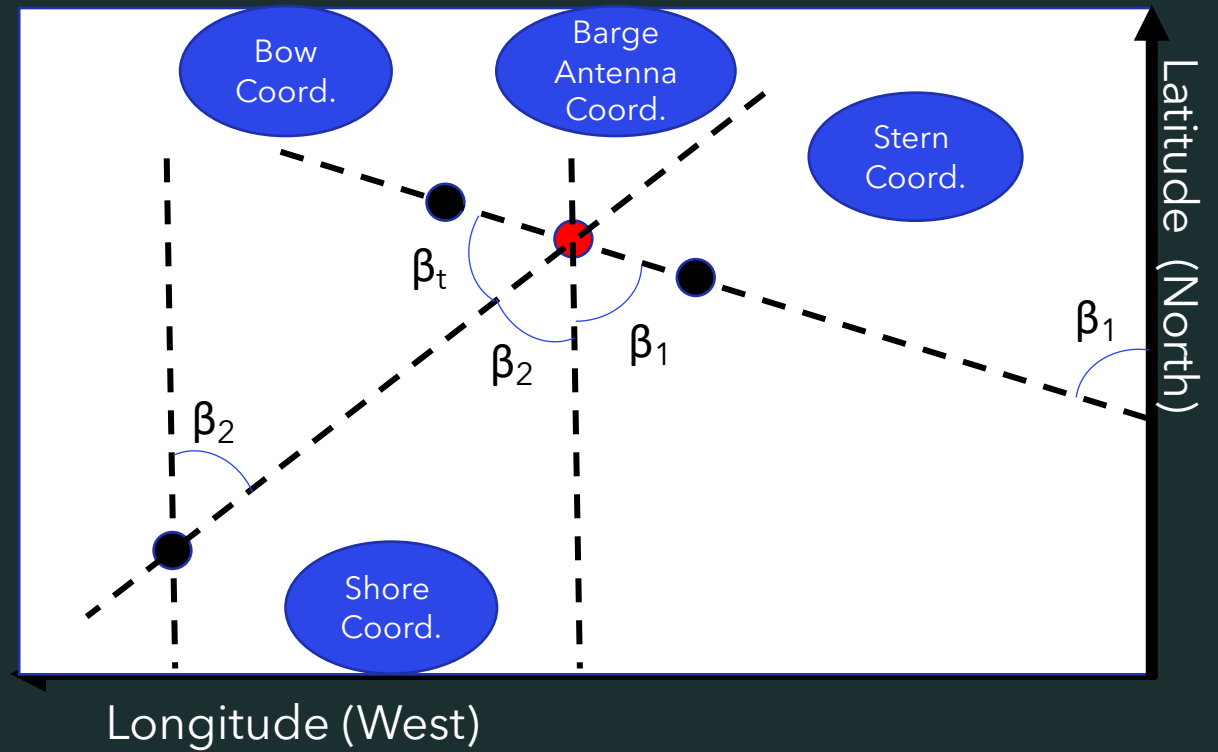
Angle Calculations

- Angle of Rotation (β_t) is Relative to Bow of Barge
- All angles will be converted to degrees

$$\tan^{-1}(1/m_1) = \beta_1$$

$$\tan^{-1}(1/m_2) = \beta_2$$

$$\beta_t = 180^\circ - (\beta_1 + \beta_2)$$

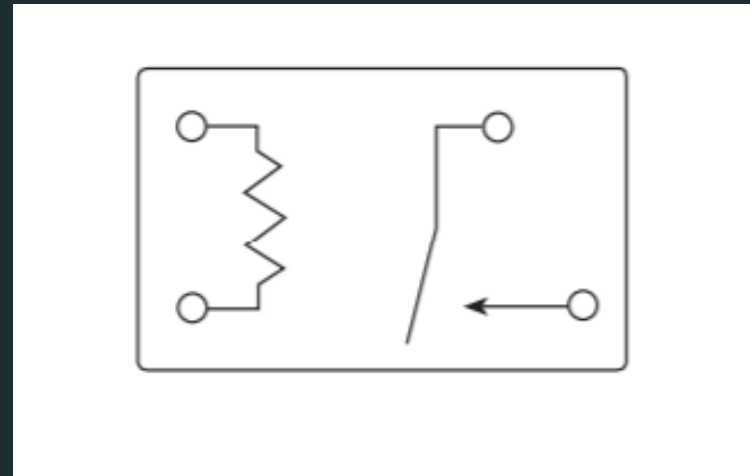




Power System

Power System Components

- Power supply
- 9V Relay
- ON/OFF Switch





System Housing

Validation of Design

Senior Capstone Design				
Project: Closed Loop Remote Control of a Directional Antenna		Primary Author: Ethan Morris		
Team: Sea Scanners		Date: 10/22/2020		
Design Validation Plan & Results (DVP&R)				
Requirement	Test	Test Subject	Target Date	Result
Maximum weight shall not exceed 15 lbs	Weigh the full system on the scale in GJ 126	Fully functional prototype	3/20/21	
Antenna shall rotate to needed direction regardless of the barge's position	Will Put the system on a rotatable board with the two GPS transmitters on the ends	Antenna, power, and control subsystems	3/13/21	
Control System should keep track of antenna's directional angle while powered down,	Will put the system on a board, same setting as the test above, and continually power down	Antenna, power, and control subsystems	3/13/21	
Control System should determine antenna's position and send appropriate rotating	Give the Arduino the "bow" and "stern" coordinates and the fixed coordinate and verify the	Control subsystem	1/15/21	
Keep the electrical components below a certain temperature	Run the system nominally and measure the temperature within the box	Power Supply, motor, and arduino	3/17/21	
Enclosure must keep electrical components dry	Pour water over the finished prototype to see if any area inside gets wet	Enclosure and base plate	2/15/21	
Control System should receive GPS coordinates from stern and bow	Verify the GPS position is transmitted to control system from two transmitters.	Control subsystem	1/15/21	
Power supply will deliver a quiet signal to the arduino and stepper motor driver	Measure power input signals to ensure correct values and reduced noise	Power supply	2/1/21	

Budget

Sea Scanners Budget: \$1000												
Item	Description	Purchase Date/Amount						Totals	% of budget	Remaining		
		Oct	Nov	Dec	Jan	Feb	Mar				Apr	
Control System								\$ 67.32	7%	\$1,000.00		
Arduino	Main control unit x1		\$ 23.00						2%	\$977.00		
Stepper Motor	Stepper motor to drive antenna x1		\$ 13.99						1%	\$963.01		
Arduino Case	Case for control unit x1		\$ 9.90						1%	\$953.11		
Motor Driver	Interface for arduino to motor x1		\$ 9.50						1%	\$943.61		
Arduino USB Cable	USB cable interface to arduino x1		\$ 3.95						0%	\$939.66		
Wires	Set of jumper wires x1		\$ 6.98						1%	\$932.68		
Power System								\$ -	0%	\$932.68		
Rectifier	120VAC to 9VDC Rectifier with extension								0%	\$932.68		
Switch	Two-way directional ON/OFF switch								0%	\$932.68		
Relay	4-pin 12V relay								0%	\$932.68		
Supplies/construction								\$ 99.00	10%	\$932.68		
3-D printer access									0%	\$932.68		
Fiberglass materials	Fiberglass kit								0%	\$932.68		
PVC	PVC for base								0%	\$932.68		
Antenna	Antenna designated by client; airMax NanoBeam					\$ 99.00			10%	\$833.68		
Shipping + taxes								\$ 13.36	1%	\$833.68		
Running total		\$ 13.36								\$820.32		
								\$ 179.68	18%	\$820.32		

Looking Forward

- Incorporating GPS Components into Design
- Code Troubleshooting
- Adjust Algorithm to Avoid Antenna Cable Coiling
- Research Feedback System For Stepper Motor
- Finalize Enclosure/Thermal Management

Questions



Thank you!