Autonomous Lifeguard

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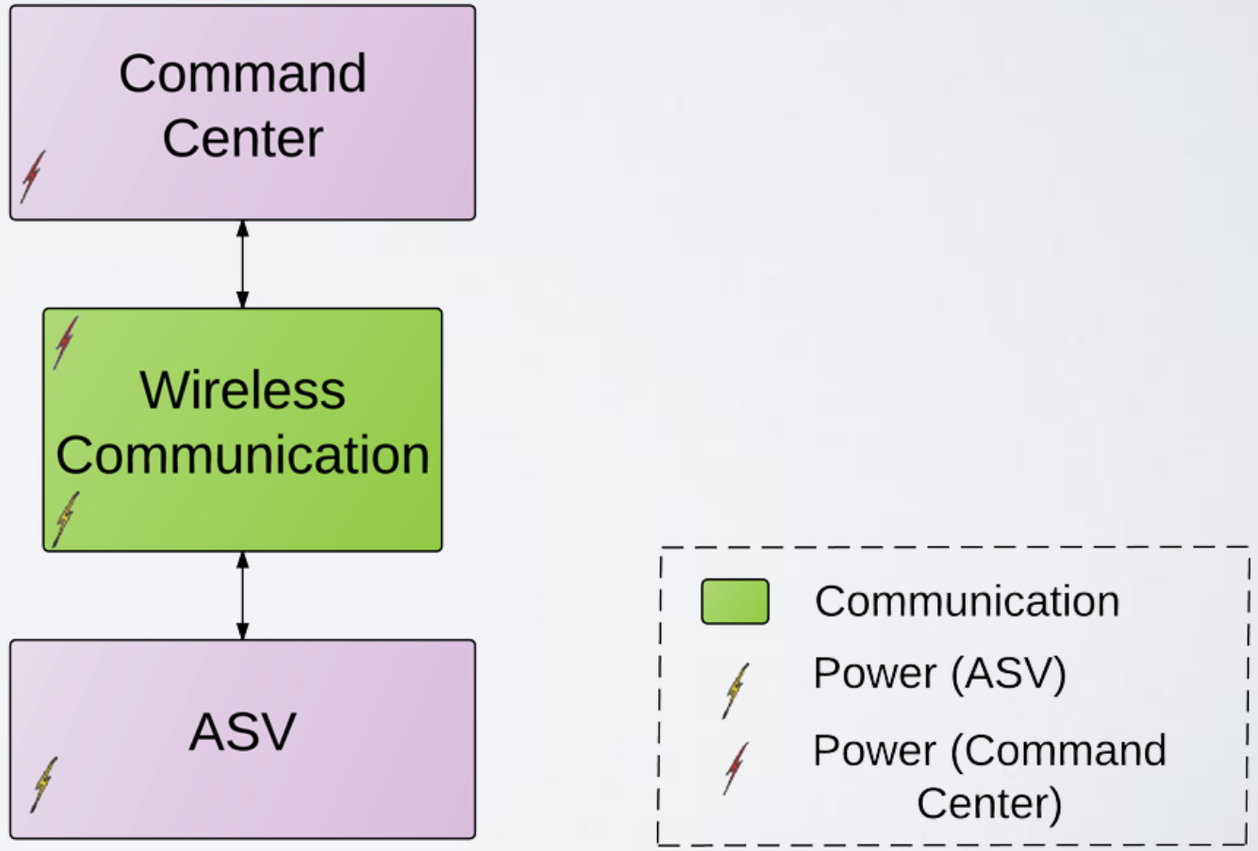
Mission Statement

- Autonomous surface vessel (ASV) to aid and assist drowning victims.
- 2-part system:
  - Command Center
  - ASV



Motivation

- Santa Cruz - “Surf City”
- E.M.I.L.Y - Emergency Integrated Lifesaving Lanyard
- Remote controlled
- Deployed from beach
- Non-practical

Objective

Develop a system that will aid drowning victims.

Scope of Specifications

- Range of rescue will be from beyond surf breaks to 600ft.
- ASV will be anchored at a specified waypoint in the water.
- Command Center will be located on a lifeguard post.
- Both subsystems will communicate via wireless protocol.

Minimum Functionality

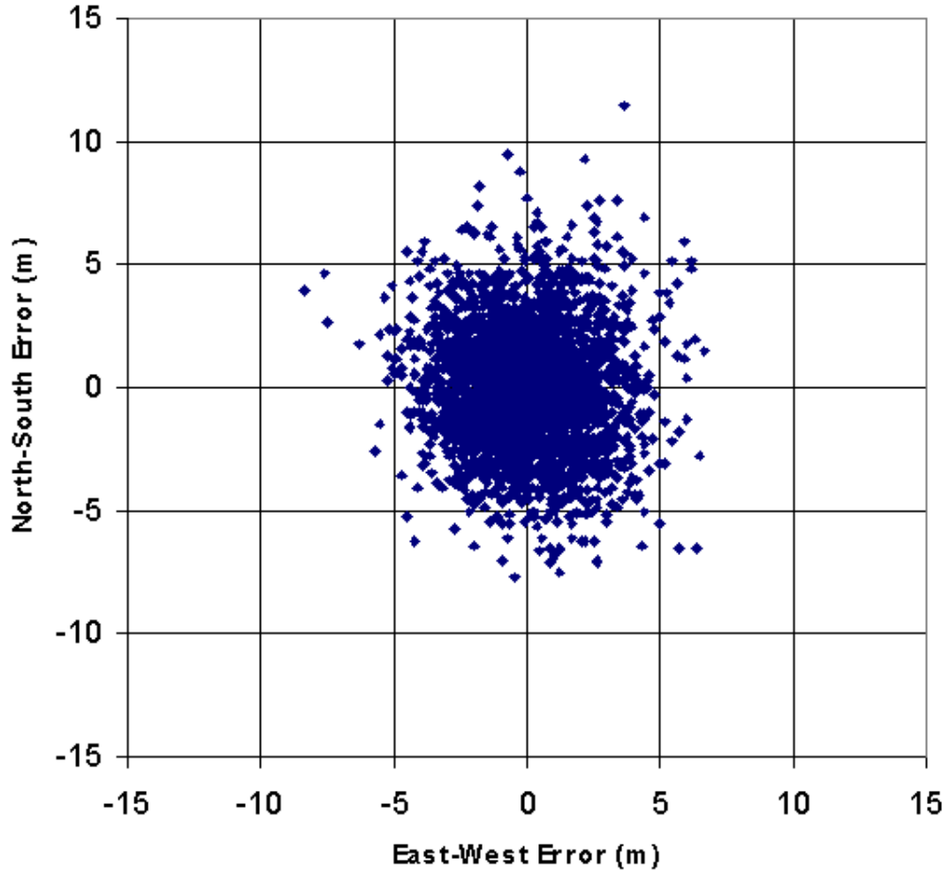
- **Command Center**
  - Obtain the drowning victim's location within +/- 50 ft.
  - Required to send wireless information at least 600 ft.
  - Must have an override remote control function allowing full control of ASV.

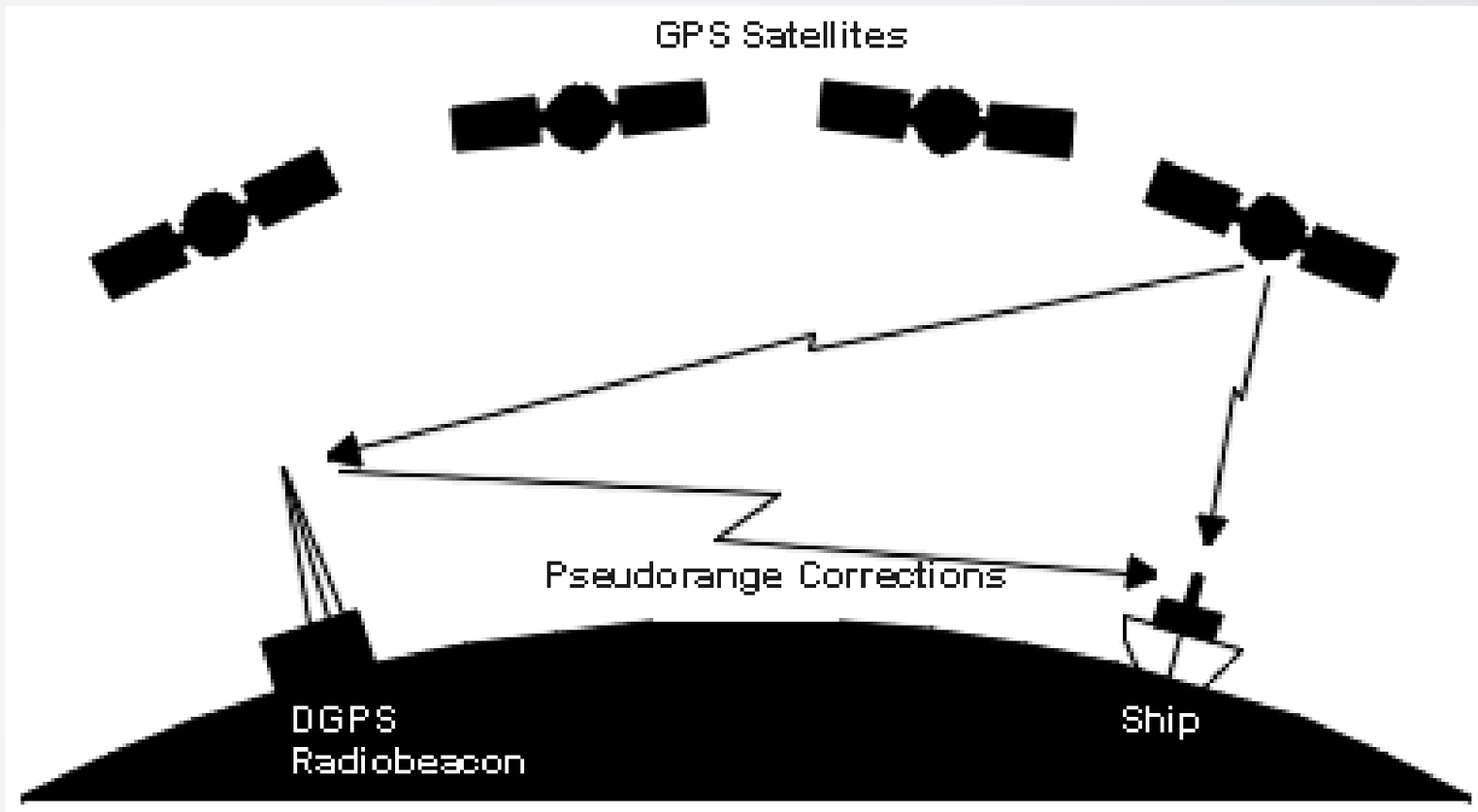
Minimum Functionality

- **Autonomous Surface Vehicle:**
  - Speed of ASV must, at least, double that of a lifeguard's swim speed (3.7 MPH).
  - Batteries must last for at least 12 hours without recharge.
  - Must be able to navigate to a specified GPS coordinate within +/- 20 ft.

Differential GPS

- Calibrate reference station position average over time
- Calculate instantaneous GPS error
- Transmit error to rover for corrections
- 1.1cm to 3.2ft of accuracy achieved





Encoder Accuracy

Resolution (bits)	Distance dy (ft)			
	200	400	600	800
12	0.307	0.614	0.920	1.227
14	0.077	0.153	0.230	0.307

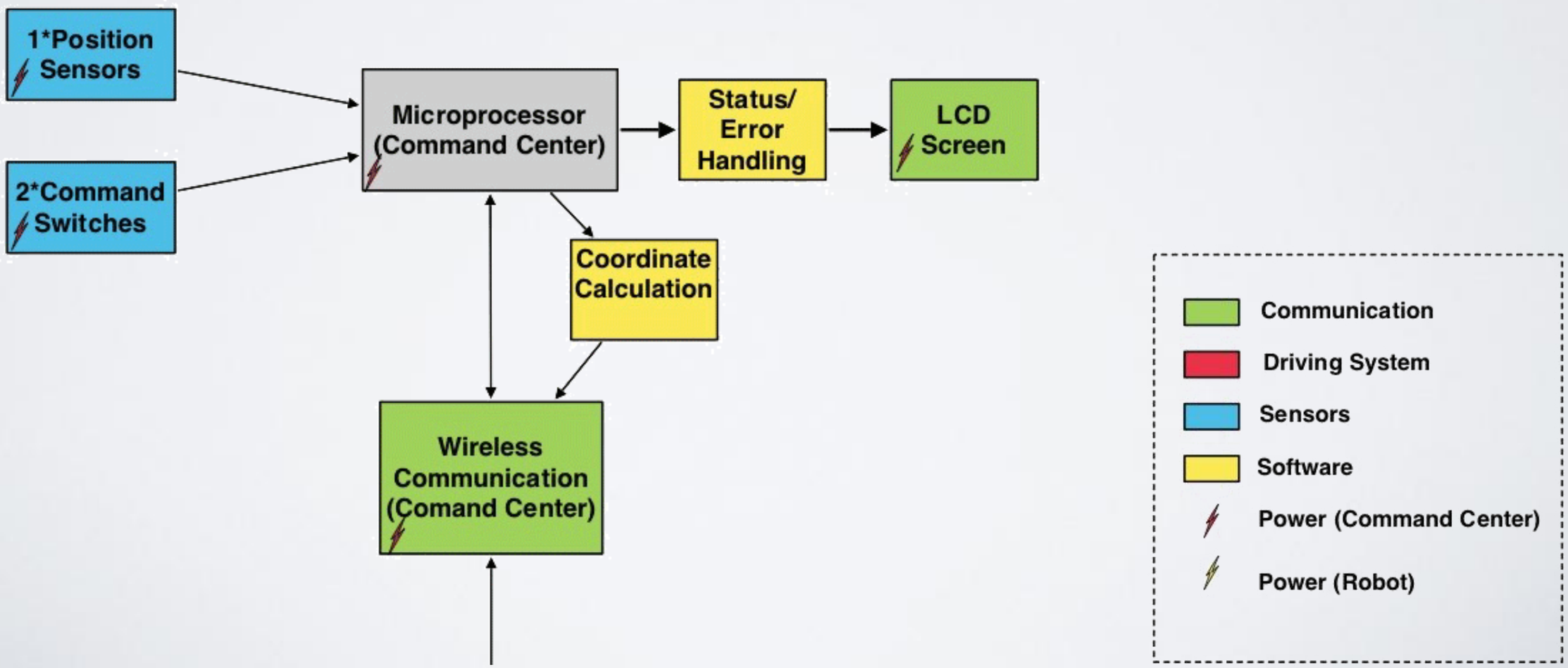
Vertical Height(ft)	10			
Resolution (bits)	Distance dy (ft) and angle equivalent from horizon			
	200	400	600	800
	87.14	88.57	89.05	89.28
12	6.346	26.164	60.838	111.926
14	1.550	6.235	14.135	25.324

Vertical Height(ft)	15			
Resolution (bits)	Distance dy (ft) and angle equivalent from horizon			
	200	400	600	800
	85.71	87.85	88.57	88.93
12	4.200	17.084	39.247	71.307
14	1.034	4.139	9.353	16.710

Vertical Height(ft)	20			
Resolution (bits)	Distance dy (ft) and angle equivalent from horizon			
	200	400	600	800
	84.29	87.14	88.09	88.57
12	3.147	12.692	28.976	52.329
14	0.778	3.099	6.991	12.471

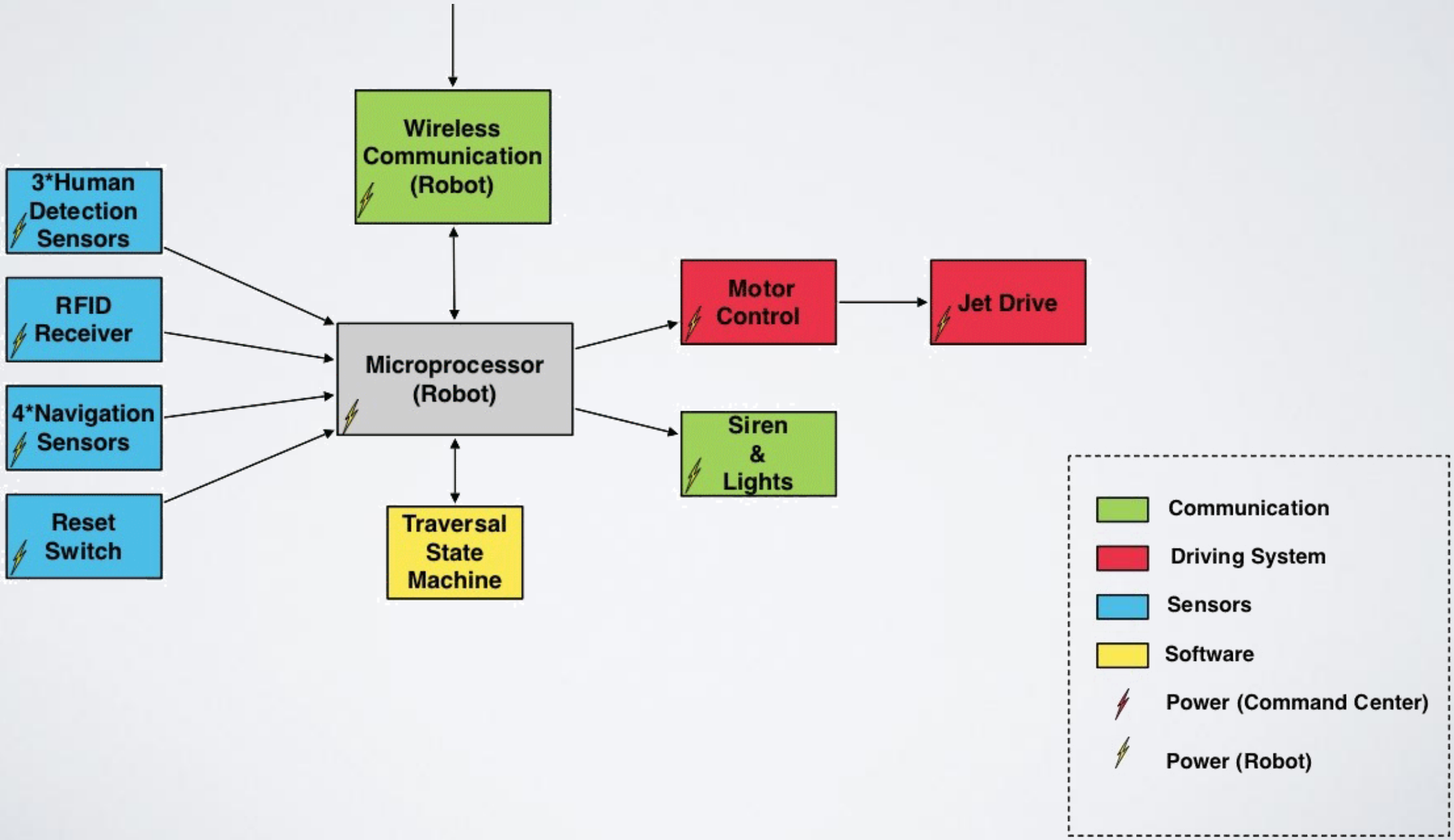
Block Diagram

- Command Center



Block Diagram

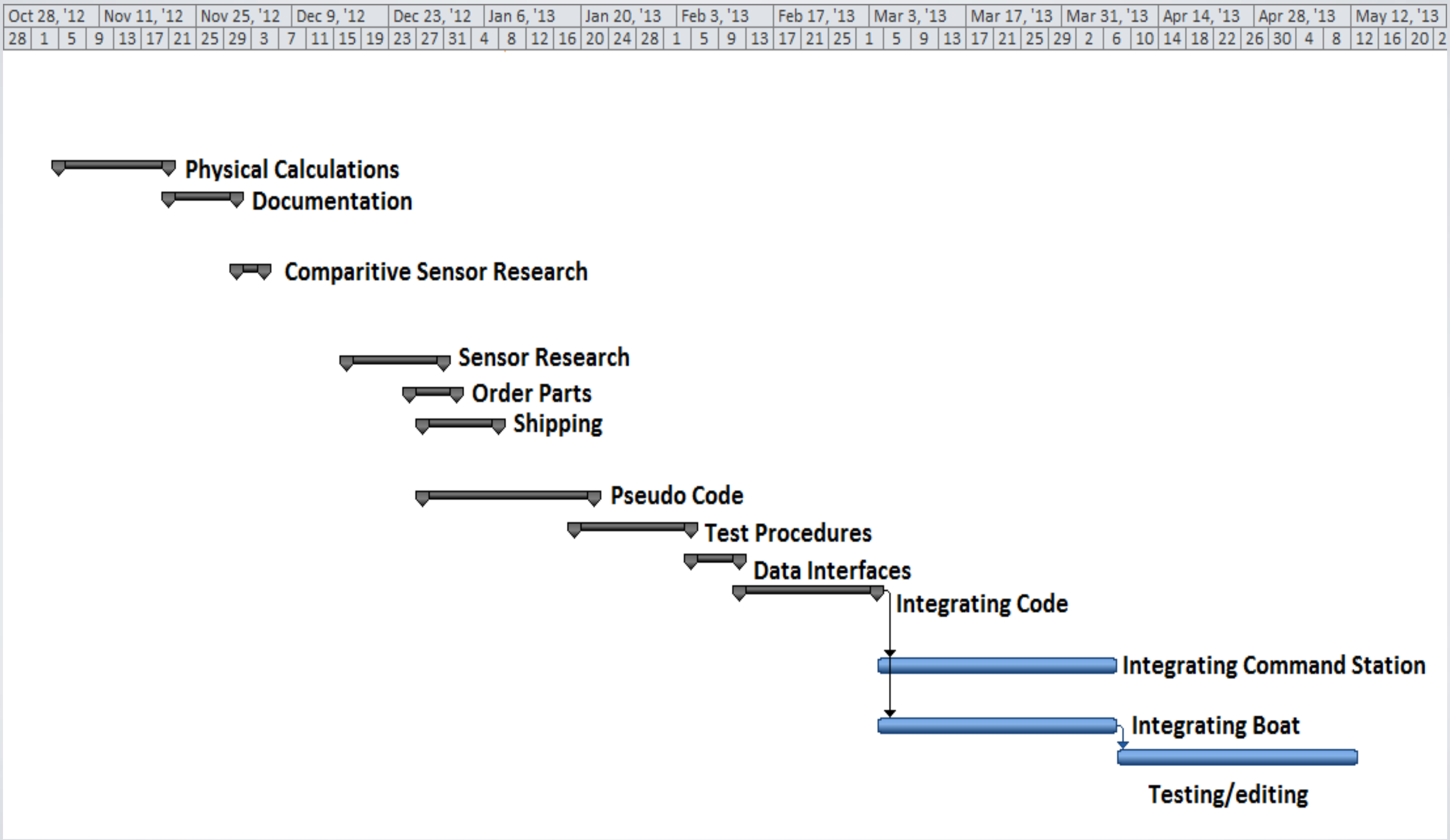
- ASV



Division of Labor

- John Ash – *Schedule Planner*
  - *Wireless Protocol, Power Management, PCB Routing*
- Shehadeh Dajani – *Budget Coordinator*
  - *Motor Control, PCB Design/Layout, Vehicle Design*
- Darrel Deo – Team *Leader*
  - *Sensor Integration, Tripod Design, Modeling*
- David Goodman – *Document Administrator*
  - *Software Test Harnesses, FSM Design, GPS Integration*

Gantt Chart


Oct 28, '12
Nov 11, '12
Nov 25, '12
Dec 9, '12
Dec 23, '12
Jan 6, '13
Jan 20, '13
Feb 3, '13
Feb 17, '13
Mar 3, '13
Mar 17, '13
Mar 31, '13
Apr 14, '13
Apr 28, '13
May 12, '13
28 1 5 9 13 17 21 25 29 3 7 11 15 19 23 27 31 4 8 12 16 20 24 28 1 5 9 13 17 21 25 1 5 9 13 17 21 25 29 2 6 10 14 18 22 26 30 4 8 12 16 20 2
Physical Calculations
Documentation
Comparitive Sensor Research
Sensor Research
Order Parts
Shipping
Pseudo Code
Test Procedures
Data Interfaces
Integrating Code
Integrating Command Station
Integrating Boat
Testing/editing

Itemized Budget

Item #	Qty	Cost (each)	Description	Part #	Manufacturer	Vendor	Category
1	2	$173.63	45" RC Boat Hull (Giant Racer G-75 Mosquito	B757T6030	STOP	amazon	Aquatic
2	4	$30.00	RC Boat Fender Skirt (Polyform G-4 Twin Eye	G-4-BLACK	Polyform	Boater's	Aquatic
3	1	$105.00	Polyurethane Expanding Foam		Various	Boat Builder	Aquatic
4	3	$53.09	AquaCraft 28-35-2200kV Brushless Motor	AQUB1805	AquaCraft	Tower	Aquatic
5	3	$28.69	Aquacraft Grim Racer 40X52/3, 3 Blade Prop, LH	AQUB9720	AquaCraft	funrcboats	Aquatic
6	2	$53.09	AquaCraft 20-Amp LiPo ESC Minimono	LXBHKP	AquaCraft	Tower	Aquatic, Power
7	2	$70.82	Turnigy nano-tech 5000mah 4S 45~90C Lipo	N5000.4S.45	TURNIGY	Hobby King	Power
8	2	$128.83	Waterproof NEMA 4X enclosure	HW-	Nema	automation	Aquatic
9	2	$91.88	3DR GPS uBlox LEA-6 Breakout	LEA-6H	uBlox	3drobotics	Navigation
10	2	$31.50	Barometric Pressure Sensor - BMP085 Breakout	SEN-11282	Bosch	sparkfun	Navigation
11	1	$18.04	Triple Axis Accelerometer Breakout	MMA8452Q	Freescale Semi	sparkfun	Navigation
12	1	$61.18	Triple-Axis Digital-Output Gyro ITG-3200	ITG-3200	InvenSense	sparkfun	Navigation
13	1	$246.26	Barska Blackhawk ED Spotting Scope 20-60x	AD11520	Barska	midwayusa	Navigation
14	1	$96.19	Vortex High Country Backpack Tripod	HCOUNTRY	Vortex	midwayusa	Navigation
15	4	$22.51	12-bit Absolute Magnetic Rotary Encoder with	AS5045-ASST	ams	ams	Navigation
16	2	$73.35	MLX90620 FIRray:16X4 Far InfraRed Array	MLX90620	Melexis	Future	Navigation
17	4	$20.03	Infrared Proximity Sensor - Sharp GP2Y0A21YK	SEN-00242	Sharp	sparkfun	Navigation
18	1	$42.89	XBee Pro 60mW U.FL Connection - Series 1	WRL-08710	Digi	sparkfun	Communication
19	2	$42.89	XBee Pro 60mW PCB Antenna - Series 1	WRL-11216	Digi	sparkfun	Communication
20	3	$5.18	Breakout Board for XBee Module	BOB-08276		sparkfun	Communication
21	8	$3.08	2mm 10pin XBee Socket	PRT-08272		sparkfun	Communication
22	1	$7.33	2.4GHz Antenna - Adhesive (U.FL connector)	WRL-11320	TE Connectiviy	sparkfun	Communication
23	1	$65.12	RFID Excalibur K9classicedp K9 Alarm	K9CLASSICED	Excalibur	amazon	Communication
24	1	$56.30	Super High Intensity LED Waterproof Emergency	PSZLEDSTB04	OLS	amazon	Communication
25	2	$5.42	Anti-Theft High dB Lond Mini Piezo Siren for Car	B00A8DGAMQ	BestDealUSA	amazon	Communication
26	4	$60.00	Board Runs				Other
27	1	$150.00	Discrete Components				Other
28	1	$200.00	Materials				Other
29	4	$11.96	PIC32MX320F128H uController	PIC32MX320F1	Microchip	microchipdir	Other
30	3	38.04	chipKIT Uno32	CHIPKIT	Microchip	digilentinc	Other
31		$166.65	Continuancy (5%)				
Total		3535.42					

Progress

- Boat Hull has been ordered and is in route.
- Started extracting coordinate data from GPS devices.
- Established Xbee communication.
- Beginning to interface decoder wheels with Micro.
- Currently seeking funding sources (Kresge, Oakes, Crown, and Corporations.)

Conclusion

- All team members are proficient in their field of responsibility.
- Gabriel Elkaim has shown support and offered mentorship.
- We have access to field testing environments (e.g. pool, lake, ocean).
- This project has the real potential to be an asset to lifeguards and save lives.
- Marketable to beaches across the country.

References

- EMILY:
  - http://www.popsci.com/gadgets/article/2010-06/invention-month-robot-lifeguard