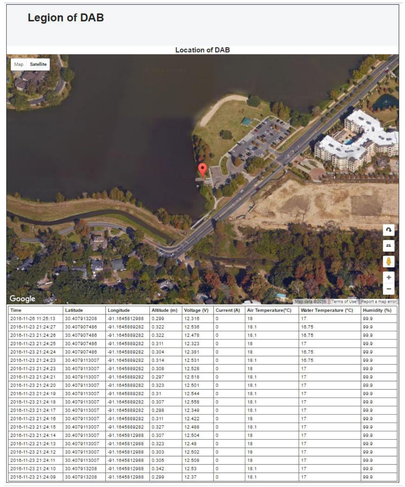
Autonomous DAB Data Acquisition Boat

Objective

Coastal studies are extremely important in states like Louisiana, with a large amount of coastal and marine industries. Data collection is crucial to the study of these environments, but it is expensive when done by humans. DAB is an autonomous boat that is fitted with temperature and humidity sensors in order to collect this data cheaply, accurately, and over a long period of time. The boat operates wirelessly, following waypoints, and transmitting its data to either a ground station, or to an off-site server, depending on the application.

Website



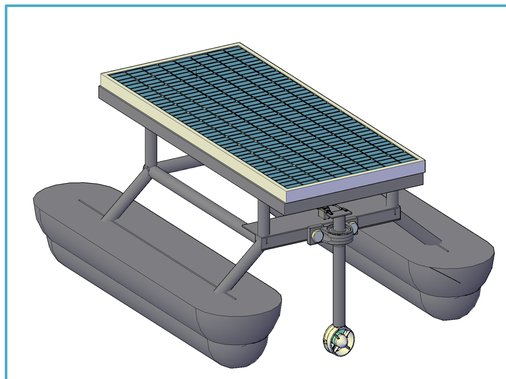
Time	Latitude	Longitude	Altitude (m)	Voltage (V)	Current (A)	Air Temperature(°C)	Water Temperature (°C)	Humidity (%)
2016-11-26 11:25:13	30.407913208	-91.1645912868	0.299	12.318	0	18	17	99.9
2016-11-23 21:24:27	30.40790748	-91.1645899282	0.322	12.536	0	18.1	16.75	99.9
2016-11-23 21:24:26	30.40790748	-91.1645899282	0.322	12.479	0	18.1	16.75	99.9
2016-11-23 21:24:25	30.40790748	-91.1645899282	0.311	12.523	0	18	17	99.9
2016-11-23 21:24:24	30.40790748	-91.1645899282	0.304	12.581	0	18	16.75	99.9
2016-11-23 21:24:23	30.40791135O7	-91.1645899282	0.3114	12.531	0	18.1	16.75	99.9
2016-11-23 21:24:23	30.40791135O7	-91.1645899282	0.308	12.528	0	19	17	99.9
2016-11-23 21:24:21	30.40791135O7	-91.1645899282	0.297	12.518	0	18.1	17	99.9
2016-11-23 21:24:20	30.40791135O7	-91.1645899282	0.323	12.501	0	18.1	17	99.9
2016-11-23 21:24:19	30.40791135O7	-91.1645899282	0.31	12.544	0	18.1	17	99.9
2016-11-23 21:24:18	30.40791135O7	-91.1645899282	0.307	12.558	0	18.1	17	99.9
2016-11-23 21:24:17	30.40791135O7	-91.1645899282	0.299	12.349	0	18.1	17	99.9
2016-11-23 21:24:16	30.40791135O7	-91.1645899282	0.311	12.422	0	18	17	99.9
2016-11-23 21:24:15	30.40791135O7	-91.1645899282	0.327	12.488	0	18.1	17	99.9
2016-11-23 21:24:14	30.40791135O7	-91.1645912868	0.307	12.504	0	18	17	99.9
2016-11-23 21:24:13	30.40791135O7	-91.1645912868	0.323	12.48	0	18	17	99.9
2016-11-23 21:24:12	30.40791135O7	-91.1645912868	0.303	12.502	0	19	17	99.9
2016-11-23 21:24:11	30.40791135O7	-91.1645912868	0.308	12.506	0	18	17	99.9
2016-11-23 21:24:10	30.407913208	-91.1645912868	0.342	12.53	0	18.1	17	99.9
2016-11-23 21:24:09	30.407913208	-91.1645912868	0.284	12.57	0	18.1	17	99.9

A screenshot of the website. The website lists the most recent 20 data points collected by the point, and plots the boat's most recent location on Google Maps.

Mission Summaries

Mission	Total Operation Time (hh:mm:ss)	Autonomous Operation Time (hh:mm:ss)	Total Distance Traveled Under Power (m)	Total Distance Traveled Autonomously (m)
1	00:30:46	00:02:06	269.32	105.88
2	03:42:23	03:22:19	7790.72	7503.63
3	08:21:31	08:00:16	17280.85	16949.16
4	10:49:43	04:54:51	11219	8891.79
5	12:32:53	04:22:32	11628.59	9462.28
6	00:41:15	00:00:18	1560.05	2.87
7	07:44:00	05:15:33	11597.56	11101.55
8	06:31:47	05:32:32	12485.4	12021.68
9	03:29:40	02:04:46	4817.87	4646.99
Total	54:23:58	33:35:13	78649.36	70685.83

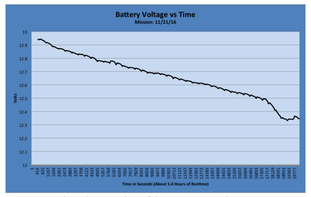
This table is a short summary of the 9 missions that the boat completed over the course of the semester.



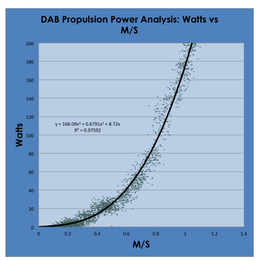
Original Design Concept

Final Design

Power Analysis

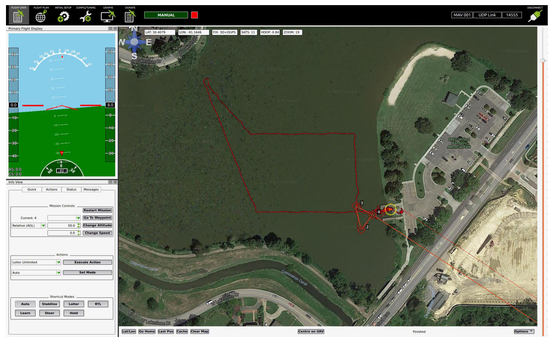


A smoothed graph of battery voltage versus time in seconds of a mission conducted on 11/21/16. This run lasted about 5.4 hours.



Plotting the power consumption vs. boat speed shows how its efficiency decreases exponentially with increased speed.

Program Display



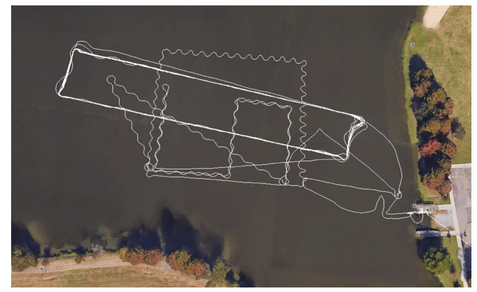
This is a screenshot of a mission from the computer HUD. It shows the course taken as well as the target points and the location of the boat. All 3 forms of communications were used in this mission:

- Manual RC Transmitter
- Close Range Radio Module
- 3G Cellular Service

Engineering Requirements

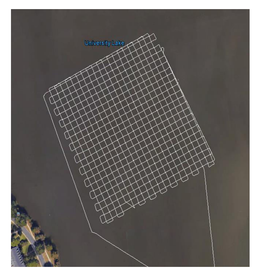
Engineering Requirements	Justification
The main battery must have a capacity of no less than 100 Ah.	A high capacity battery allows longer operation.
The average continuous power draw for all components must be no more than 12% of the capacity of the battery.	This will allow an 8 hour average operation time.
The boat must be no larger in area than 4 feet wide, 6 feet long, and 3 feet tall.	These are reasonable dimensions if the boat is to be transported in a truck bed.
The entire boat must weigh less than 150 pounds.	This allows easy portability and makes the boat travel more efficiently.
The boat must have a GPS with a resolution of at most 2.5m, and navigational calculations must be done with a loss of less than 0.1m.	Accurate navigation is crucial to the basic operation of the boat, as well as accurately GPS-tagging collected data.
All interior components and electronics must be contained entirely within waterproof containers, or otherwise waterproofed.	Contact with water will ruin most electronics and could cause shorts in circuitry.
All exterior components must be resistant to rusting, rotting, and other corrosion.	Water environments offer specific corrosion challenges.
Energy consumption must be monitored and a 10% emergency buffer should be considered at all times.	A buffer of 10% will help the boat to deal with unexpected weather conditions, component failures, and other emergencies.
Temperature readings must be made with an error no greater than $\pm 0.5^{\circ}$ C.	A threshold needed to indicate that the boat is returning accurate temperature.
All information must be communicated to the user via wireless communication methods (either 3G or XBee, depending on the specific environment).	Wireless communication is the only practical communication paradigm for this project.

Navigational Calibration

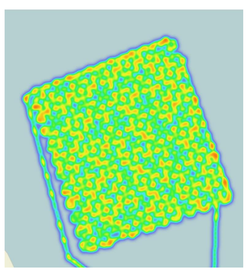


The jagged lines in this mission represent a completed untuned steering system, and the rectangle was run many times at different speeds in order to gather power data on power consumption vs. speed.

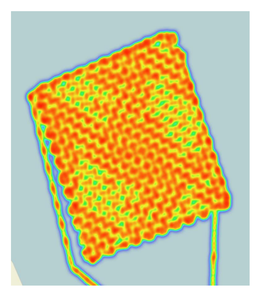
Data Collection & Visualization



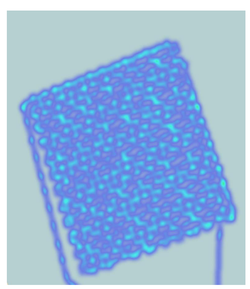
This is a precision run made in University Lake, the goal of which was to collect humidity, air temperature, and water temperature data. These are plotted below.



A map of humidity data in University Lake.



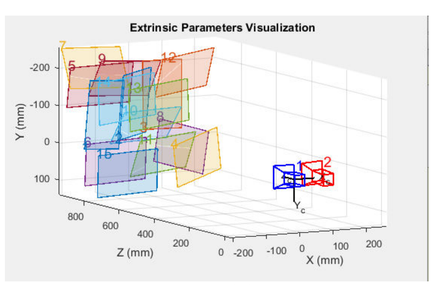
A map of air temperature in University Lake.



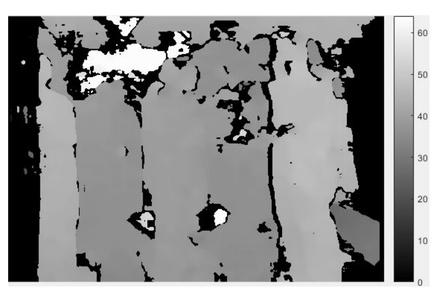
A map of water temperature in University Lake.

Object Detection Using Stereo Vision

Using a fixed dual camera system, we are able to detect the approximate distance from an object. The distance is found with an algorithm using the disparity between the two camera angles.

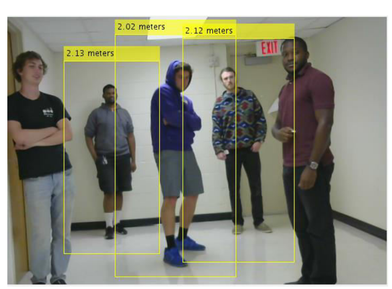


Camera Calibration



Disparity Map

Canny Edge Detection



Detected People