LaPRAS: Laboratory Pontoon Remote Aquatic Surveyor

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ME424 Design 2015

Objective

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To design a budget-friendly, remote control vehicle for ocean research that is both reliable and easy to maintain.

Capabilities:

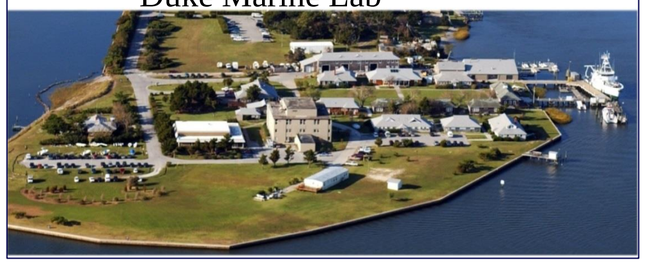
1. Record video
2. Track pH, D. O., and temperature
3. Allow simple upgrades or additions

Customer

Dr. Brian Silliman

Requested visual and sensor surveys of fish populations

Duke Marine Lab



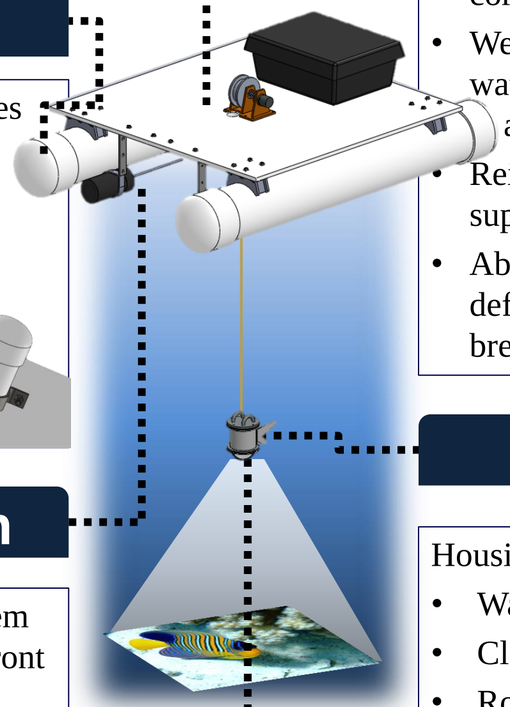
Acknowledgments

- Pat and Nikhil
- Dr. Gustafson
- Dr. Kielb
- Steve and Greg
- Doug Nowacek
- Siyi Zheng

Final Design: Catamaran Vehicle

Key Design Features

- Highly modular
- Easily disassembled and reassembled
- Entirely controlled by Raspberry Pi with 12 V power supply



Pontoons

Two 6.65"x4' PVC pipes support craft

- Supports 90 pounds
- Securely attached to deck with belts
- Filled with foam in case of leak

Propulsion

- Twin-propeller system pulls vehicle from front
- Propellers may be operated independently
- Zero degree turn radius
- Low heat output
- Completely waterproof design

Deck

- Marine grade high-density polyethylene
- Strong, lightweight, corrosion-resistant
- Well-placed holes allow water drainage and modular attachments
- Reinforced by structural supports
- Able to undergo large deformations without breaking

Housing

Housing encloses camera

- Waterproof
- Clear viewscreen
- Rotating shark fin adds stability in water

Elevation is controlled by winch on deck

- Position control with servo

Camera

As-built prototype contains Raspberry Pi camera module

- 720p @ 60 FPS
- IR capability
- Illuminated view

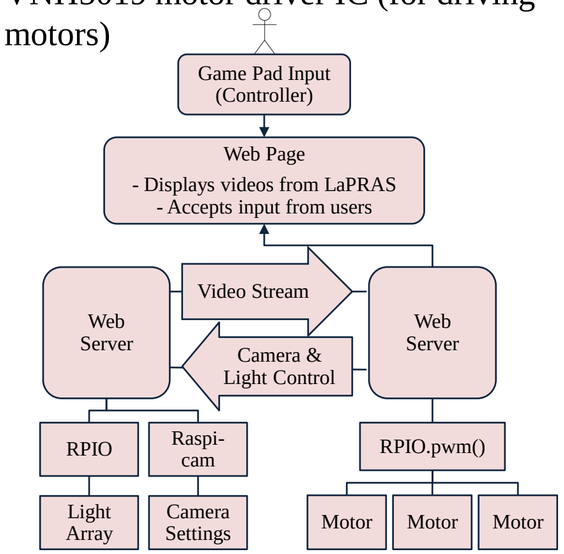
Design allows for the mounting of aftermarket cameras

Critical-to-Customer (Criteria)	Critical-to-Quality (Goal)	Capabilities (Product)
1. Stable in water " "	1. Average wave causes roll < 15º Self-right up to 90 degrees	1. **Confirmed** in pool test. **Confirmed** in pool test.
2. Non-invasive " "	2. < 100 dB at 5' depth Minimal wake / drag	2. **Untested** **Confirmed** in pool test.
3. Sturdy	3. Hold 20 pounds (excl. hulls)	3. Holds one Mike (>20 pounds).
4. High Quality Video	4. 720p @ 60 FPS, 1080p @ 30	4. **Guaranteed** by product choice.
5. Underwater Video	5. Camera depth of 5 feet	5. Depth adjustable to 10 feet.
6. Inexpensive	6. Assembled Materials < $1500	6. Current budget < $1000.
7. Maneuverable	7. Zero turn radius, 4 knot speed	7. **Expected** by propulsion design.
8. Remote Operation	8. 100 foot control range	8. **Tethered control**

Controls

L293D (for servo and control motors)

VNH5019 motor driver IC (for driving motors)



Power Supply

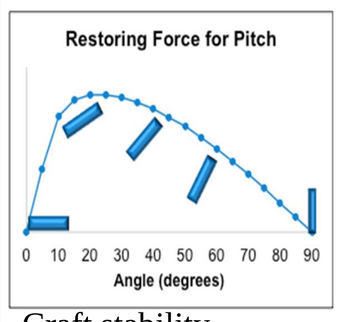
Prototype includes tethered power supply

Next generation vehicle will use on-board Lithium-ion battery: good power density, expensive, easily replaceable

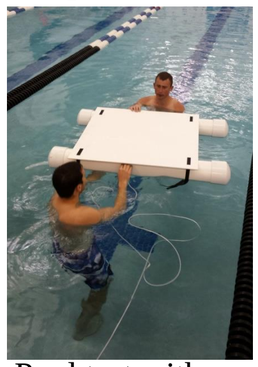
Prototype Testing

Tests in Taishoff pool include analysis of buoyancy, stability and drag

- Drag coefficient is 0.08, equivalent to a streamlined body
- Recovered from 80º tilt angle



Craft stability confirmed up to 80º



Pool test with Mike and Andy