Divide and Conquer Report
EEL4914 Summer 2020

Visual Depth Finder

Group Number: 7
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Motivation

Mankind has made its most significant advancements by satisfying our need to explore what we do not understand. Our *curiosity* has allowed us to discover amazing new technologies and physical understanding, hence the namesake of one of the greatest exploration projects in human history. From wooden ships crossing oceans to metal rockets crossing solar systems, it has never been satisfactory to not know and simply conjure a guess. Our need to learn will continue to propel us to an enlightened future.

Water is one of the great unknowns to mankind. It is the one place that humans venture where we are entirely unequipped for survival. As depth increases, light fades, and the world below becomes more strange and unobserved. In water lies foreign creatures, unknown dangers, and yet more mystery. Many bodies of water give no information upon observation beyond the color of their surfaces. From fisherman to off road adventurers and marine biologists, there are many scenarios we encounter that beg the question, “What’s in there?”.

It is the directive of this project to provide a lightweight, portable solution to this problem. We will build a system that provides an analytical introduction to bodies of water, inshore and offshore.

Background

The past ten years have seen a huge surge in devices that provide air exploration to any user. The “drone” is a weekend hobby, essential tool for law enforcement, and even a weapon. While the aerial drone market floods, there are few options for similar underwater exploration. The term underwater exploration typically conjures thoughts of miniature submarines visiting the Titanic and pirate wrecks, but what about a system to collect the most essential readings of a

body of water? These readings are its depth, temperature, and contents, and will be the core functions of this project.

Requirements Specifications

Requirements for the entire system will be split into three levels. The first will be the system operating as a whole. Level 1 will state requirements for the controller and boat operating together. The second level of requirements will be directed toward how the boat should operate. The third level of requirements specifies how the controller shall operate.

Level 1

* **Note:** Within this section of Level 1 requirements, "The System" will refer to the combination of the exploration vessel and its remote controller with data display.

- The system as a whole shall be lightweight and easily portable
    - Weight Limit: 15lbs
    - Dimensions: 18in x 8in
        - Possible travel case requirement
    - Maneuverability
- The system price shall not exceed $500
- The system shall have a battery life to sustain ample exploration.
    - Minimum Time of Operation: 8 minutes
- The system shall be rechargeable
- The system shall be able to work in different environments or bodies of water, i.e, pool, lake, etc.
- The system shall be waterproof
    - IP68+ rating
- The system shall be able to withstand reasonable shock from impacts with possible obstacles (stumps, waves, etc)
- The System shall be able to receive and transfer video, depth data, and temperature values to the remote control display wirelessly.
- The system shall use 433Mhz RF modules or 2.4Ghz RF modules
- The System shall be able to communicate and transmit data back and forth within a specific range
    - Control Range: TBD
    - Temperature Sensor Data Transfer: Range - TBD
    - Depth Sensor Data Transfer: Range - TBD
    - Live Camera Feed Data Transfer: Range -TBD

Level 2

*** Note:** Within this section of Level 2 requirements, "The System" will refer to the exploration vessel.

- The System shall be able to maintain buoyancy with the addition of data recording equipment.
- The System shall maintain aero and hydrodynamics with the addition of data recording equipment.
    - Display this with cone navigation
- The System shall be able to navigate waters with a depth resolution of 8mm
    - Flat hull design - See fan boats
- The System shall be able to undergo various speeds up to TBD without affecting efficiency.
- The System shall be a low power system with maximum operating voltage of 12V
- The motor in the System shall have a maximum power of 8000rpm
- The motor shall be driven by an 11.1V Lithium Polymer battery
- The System shall be able to maintain data transfer efficiency while moving
    - Depth, and temperature readings shall have accurate measurements while the vessel is in movement.
- The power system and circuitry shall have leakage protection and be completely sealed for waterproofing.
- The receiver and transceiver (RF Modules) shall have a data transfer range minimum of 10 meters
- The system shall have various voltage regulators outputting a voltage range of 3-5.5V for temp sense, 3.6-15V for microcontroller, TBD for depth sensor, and 3.3-5V for camera.
- The output current for voltage regulators shall not exceed TBD amps.
- The temperature sensor in the system shall record temperatures ranging resolution minimum of 0.5 degree Celcius and have a range between 0 C - 80 C
- The Depth sensor in the system shall be able to record depth values within the specified range of 1in - 50feet
- The camera shall be able to transmit live video feed to the remote control display

Level 3

*** Note:** Within this section of Level 3 requirements, "The System" will refer to the remote controller with data display.

- The System shall have a maximum weight of 5lbs to prevent user fatigue
- The System shall have maximum dimensions of 10x10 inches

- The System display shall maintain a frame rate of TBD
- The System shall have a display suitable for users of all eyesight abilities
    - Minimum screen size 4x4 inches
- The System shall transmit control data quickly to maintain fluid control on a body of water
    - Transfer rate TBD
- The System shall have a battery life indicator function
    - Possible alarm for low battery
    - Percentage or visual indicator ie three bars
    - Backup battery so the vessel is never stranded (move to level 1 most likely)
- The System shall be water resistant in case of rain or splash from the body of water
- The System shall have a warning when the vessel is approaching its shallow water limit
- The System shall be user friendly
    - Minimal controls: power and steer
- The system shall maintain controls of the display
    - Brightness range TBD

Table 1. Engineering-Marketing Trade Off Matrix

			Marketing Requirement			
			Ease of Use	**High Performance & Resolution**	**Range Usability**	**Speed**
			+	+	+	-
Engineering Requirements	**Weight**	-	↓	↑↑	↑	↓
	Dimensions	+	↓↓		↑↑	↓
	Data Transfer Range	+	↓	↑	↑↑	
	Power	-	↓	↑↑	↑	↑↑
	Cost	-	↑	↑↑	↑	↑

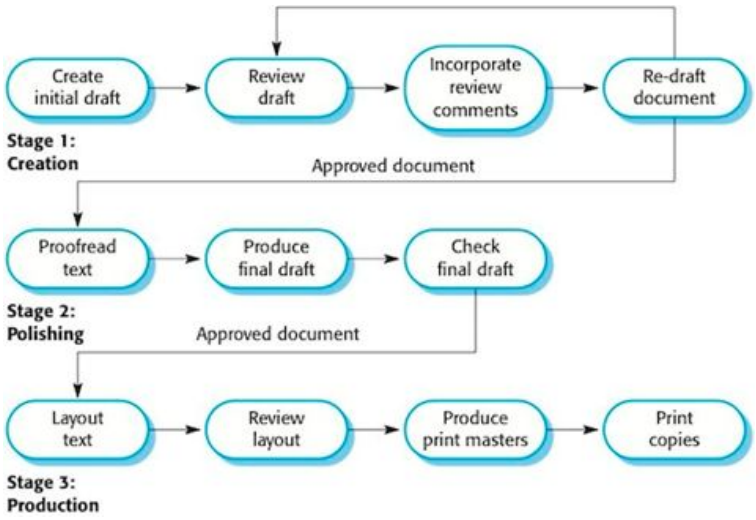
↑ = Positive Correlation
↑↑ = Strong Positive Correlation
+ = Positive Impact Requirement
↓ = Negative Correlation
↓↓ = Strong Negative Correlation
- = Negative Impact Requirement

Standards

Safety – The safety regulations for RC boats are relatively constant for any RC boat. Although our boat will likely not be relevant to this rule, it's important that any boat put in the water be checked for oil and fuel leaks so as to not pollute the body of water. It's also imperative that if any other vehicles are on the water that extra precaution be taken to avoid an accident.

Testing – While testing, regulations for putting a boat on the water varies depending on the body of water. We plan to test the boat locally first within our own property, so testing then shouldn't be an issue, but in the future, we would like to test the boat in Lake Claire at UCF. For such an occasion to occur, we would receive permission from UCF and adhere to their standards and regulations.

Documentation – The document production process will follow the following iterative process:



Design Methods – For design methods, there are a variety of different elements of the boat to consider different design choices/standards, such as fuel, the hull, and the material. Our RC boat will likely adhere to the following:

- Fuel: Electric
- Hull: Monohull (a boat with a single hull, unlike a hydroplane hull)
- Material: Plastic

Programming Languages – For programming language syntax standards, we will adhere to common coding conventions, which are as follows:

- Local variables are to be named using camel case, where the first letter is always lowercase (ex. localData).

- Global variables are to be named starting with an uppercase letter (ex. GlobalData).
- Constant names will be made up of capital letters only (ex. CONSTDATA).
- Function names will also be named using camel case.
- All function names will have some description of the purpose they serve.
- 4 space indentations will be used consistently.
- There must be a space after every comma that lies between two function arguments.
- All nested blocks will be properly indented.
- All braces will begin and end on a new line.
- Code will be thoroughly commented as to make it easily understandable.
- Lengthy functions will be avoided so as to keep the code simple

Estimated Project Budget and Financing

- Our project will be self funded with an initial budget of 500 USD. We are exploring 3rd party funding to subsidise this but it is unlikely in our current crisis.
- Below is an initial list of parts needed and a table of estimated costs.

Table 2. Estimated Item Cost (Implementation #1)

Item	Cost
SEN-11050 Temperature Sensor Waterproof DS18B20	$6.90
Flytec HQ2011 RC boat (and remote)	$69.33
Eachine TX02 NTSC Super Mini camera	$18.89
Bullet Skimmer Transducer depth finder	$39.99
Jumpers	$7.49
Pimoroni HyperPixel	$49.95
2x MSP 430	$16.51
Battery pack	$2.00
Resistors x100	$10.00
Capacitors x50	$8.50
Inductors x50	$36.00
RF 433MHz Module	$4.95

Pcb Assembly	$23.90
Regulators x10	$18.20
Transmitter and Receiver	$4.95
Total	**$334.07**

- In the case that we choose to design our own RC boat and only purchase the hull pre-made.

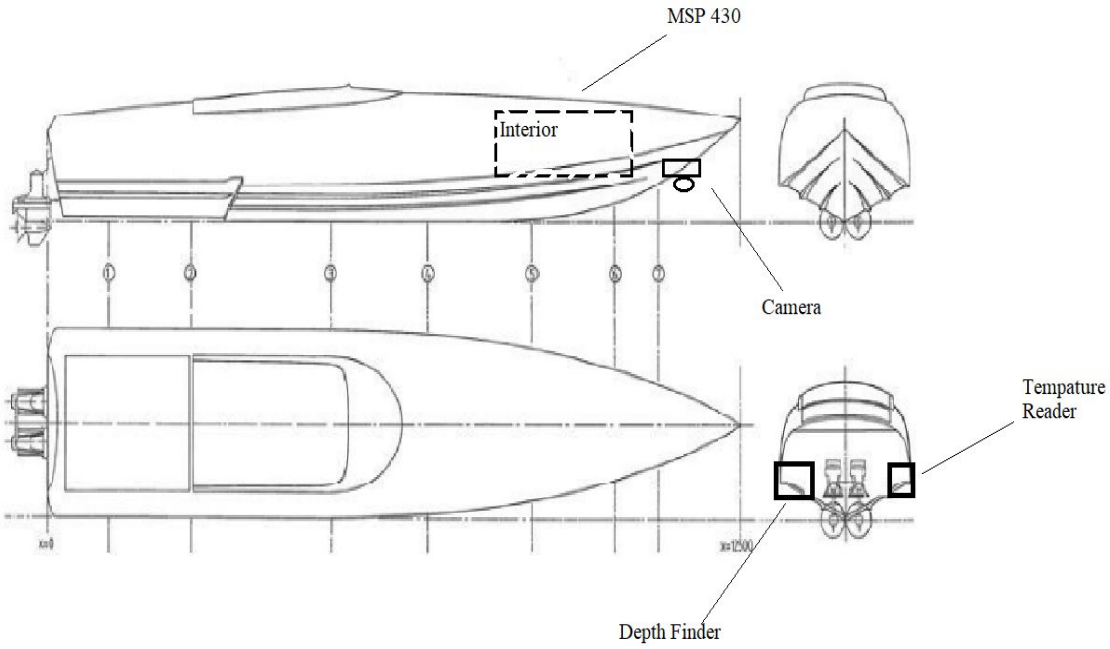
Estimated Additional Costs

Table 3. Additional Items (Implementation #2)

Item	**Cost**
Hull	$34.99
35T Motor	$25.99
Venom Group Venom 7.2V 3000mAh 6 Cell NiMH Battery	$22.99
Double Sides Brushless ESC	$16.39
Rudder	$7.40
Propeller	$6.58
Driveshaft	$6.87
Servo	$2.57
Venom Group Venom 7.2V 3000mAh 6 Cell NiMH Battery	$26.51
Total (New Total)	**$150.29 ($484.36)**

Project Prototype Illustration

Figure 1. Initial Design Illustration



Initial Project Milestone for both semesters (Red indicates UCF-imposed deadlines)

5/29 – Divide and Conquer due

6/5 – Divide and Conquer V2 due

6/25 – Theoretical Project Design "relatively" finalized (We will have a strong idea of all, if not most, of the parts we need to build and complete the project, and we may begin ordering parts.)

7/3 – 60-Page Senior Design Draft due

7/8 – Parts acquired, Production Process begins

7/17 – 100-Page Report Submission due

7/22 – Final Document completed, Review and Finalization begins

7/26 – Final Document finalized

7/28 – Final Document due

8/5 – Depth-Sensing Boat 25% Completed

8/24 – Fall Semester Begins

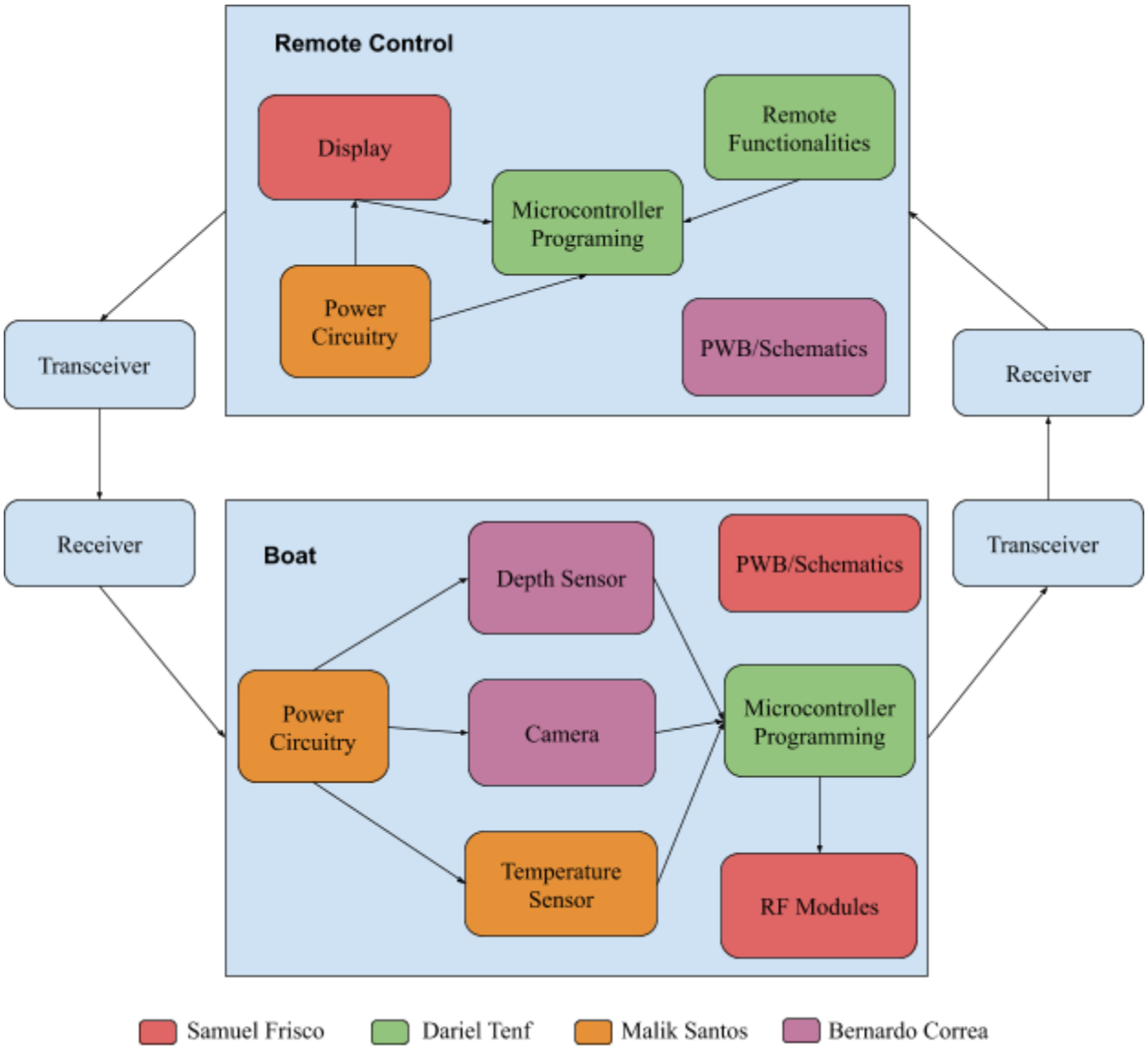
8/31 – Depth-Sensing Boat Completed, Testing and Optimization begins, Consider adding additional features if all is going as planned

9/31 – All features finalized

11/10 – Testing and Optimization Completed, Project Finalized

Block Diagram

Figure 2. Initial Prototype Block Diagram



Block Status

Power Circuitry - Research and Purchase - Researching operating voltage ranges and circuit protection for both feature and basic operation components. Also battery material options and brushed vs brushless motors. All research is being done with the goal of a single power source.

RF Modules - Research and Purchase- Finding and tuning equipment to correct frequencies.

PWB/Schematics - Research, Design and Purchase- Designing schematic digitally and then ordering the result.

Display - Research and Purchase- Installing display inside of the remote with a shared power source.

Depth Sensor - Research and Purchase - Investigate different types of sensors such as sonar for depth measurements. Research quality and resolution of part.

Temperature Sensor - Research and Purchase - Investigate different types of sensors and mounting options, as well as accuracy and the units that will be reported.

Camera - Research and Purchase - Investigate different cameras based on cost, quality, resolution, and wireless transmission

Microcontroller Programming - Research - Finding optimal coding language to use for the software design aspect of the project.

Remote Functionalities - Research - Finding how to produce the software specifically required for the different features we desire for the control of the boat.