Bayou Bot Krewe: Technical Design and Competition Strategy for the 2026 RobotX Maritime Challenge

Chris Authement, Andrew Cheung, Leo Dean, Ethan P'Pool, Evan Schwartz, Hunter Swilley, Yasmeen Qudsi, John Carroll, Dr. Jonathan Rausch

Abstract-The University of Louisiana at Lafayette's Bayou Bot Krewe joins the RobotX competition for the first time ever with experience gathered from competing in previous Roboboat competitions. Using the BlueBoat and BlueROV2 produced by Blue Robotics [4], as well as a custom UAV, the team will focus on inter-vehicle communication for purposes of positioning and completion of tasks 1 and 2 [8]. Using a combination of vision systems, LiDAR detection, GPS, and directional components, the system of vehicles will be able to communicate directions, navigate obstacles, and determine objective completion.

I. Competition Strategy

The main objectives to be completed by the team are tasks 1 and 2 [2]. The current UAV used has a max possible thrust capacity of 3.44 kg. The intended purpose of the drone is reconnaissance, and for purposes of completing task 3, was seen as inviable, due to its lack of a high lift to weight ratio. Therefore, maximizing the opportunities to gather points in tasks 1 and 2, which focus more on navigation and field recon, became the ideal choice. The UAV is equipped with a downward facing camera, which when positioned over the course, would allow for an eagle-eye view of the colored light indicators on the buoys. Through logic shown in Figure 1, a combination of image recognition and Mission Planner GPS navigation are used to create a map for the USV to navigate.

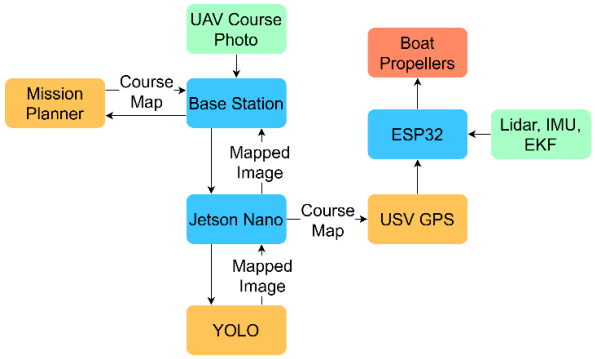


Figure 1: UAV to USV Navigation Logic

Utilizing LiDAR imaging for obstacle detection and gate tracking, the USV would then be able to navigate the course outlined by the UAV. Once reaching its finishing point, through a tethered connection to the USV, the UUV would then receive local GPS coordinates, and using the UAV for aerial recon once again, be able to navigate to its starting point.

II. Design Strategy

The primary focuses when designing software and hardware components remained in size, consistency, and adaptability. One of the main challenges going into the competition was a focus on navigating a changing environment while maintaining consistent movement. Factors such as current and wind can have large impacts on the overall movement of both aerial and surface-level water vehicles. In addition, the resolution of GPS systems can lie within ±1.5 meters of the actual position. Therefore, reliance on strictly GPS coordinates, or navigation on where a vehicle is intended to be travelling strictly on velocity logs

and angle of the vehicle became impractical. This meant a major focus of the navigation of all vehicles became situational awareness and inferencing.

III. Testing Procedure

Testing of all equipment is done first individually to determine limitations and drawbacks, second as a component to the vehicle being applied to, and third to the system. This would include feasibility testing of software and hardware integrations, for example the LiDAR sensor found on the USV. Shown in Figure 2 is a snapshot of an RVIZ [5] visualization tool for initial testing.

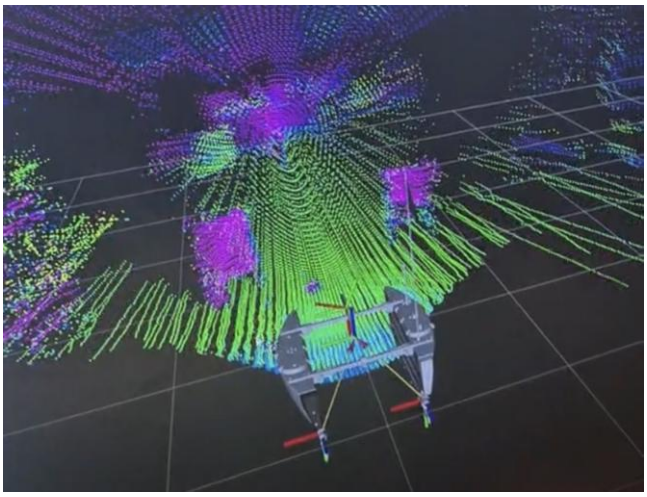


Figure 2: LiDAR RVIZ Visualization

Before the LiDAR sensor was tested for mapping, setup and calibration was first performed to determine what kind of information was being drawn from its surroundings. We then determined how to utilize that information to perform object detection and gate creation. Using the shape of an object and confidence of detection, training for buoy recognition was performed. Next, distance interpolation and recognition of two distinct buoy entities at once was developed to determine a gate to pass through. Once both types of functions were deemed successfully integrated, the logic of navigating into a gate could then be implemented with motor functionality of the larger system.

IV. Results

i. USV

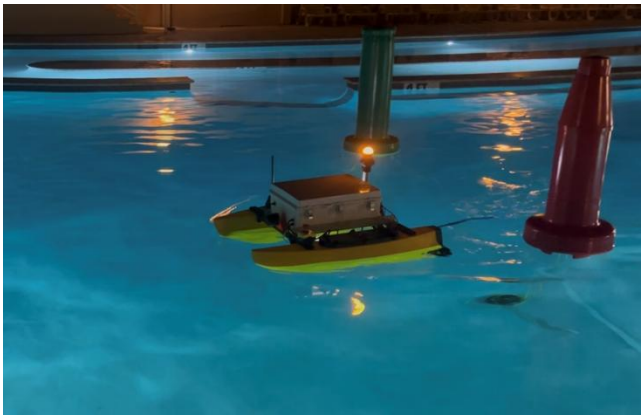


Figure 3: USV on Water

Through automated recognition of point cluster shape identification and mapping, the USV in Figure 3 can determine through LiDAR what types of obstacles are navigable. Using the confidence in recognition of a 2D mapping of its environment, the system can correctly identify what is within its peripheral and how to navigate using centering logic. Centering uses a calculation of a buoy's geometric center, and once determined for two objects, can create a midpoint between them and directing itself to that midpoint. In addition to object avoidance, the system can also follow a map created by the UAV. Utilizing YOLO [4] for image detection and a form of flood-fill algorithm, the USV is able to receive an image taken by the UAV of the course, mark points of interest, and create a path of best fit to complete its route. This allows for a dynamic mapping system, completely independent of preexisting geographic data, and can be updated in real-time for changes in its environment. To facilitate the necessary computation and storage requirements for the navigation logic, modifications were made

to the BlueBoat, the platform used to create the USV. The main feature of these modifications, shown in Figure 4, is a custom control box, with an electrical diagram and explanation featured in Appendix B.

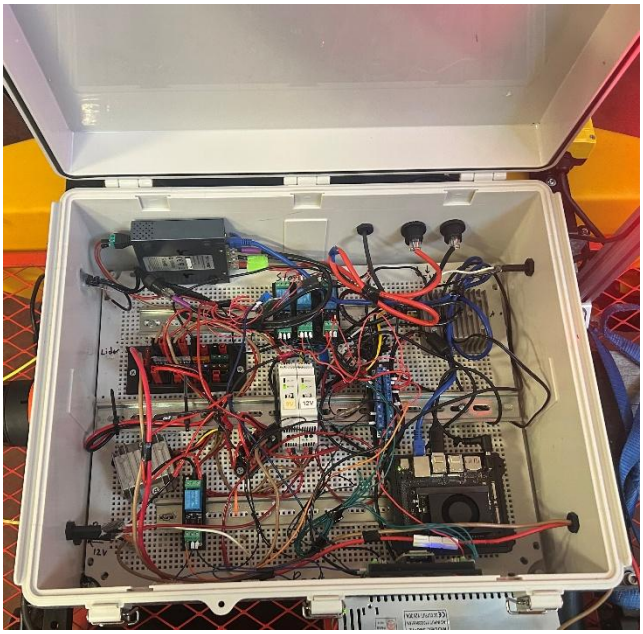


Figure 4: USV Control Box

The main features of the control box include the Jetson Orin Nano, which handles computing for the vehicle, and the ESP32, which is the microcontroller running the boat. The Jetson can receive MAVROS commands from an external source, like a laptop, and execute those commands by communicating with the ESP32, which then deploys run functions. Through this connection, different boat processes, primarily movement and directional referencing using its IMU are performed. Another main feature is the inclusion of the mount for the UUV tether. By incorporating the UUV into the USV's architecture through a hard-wired connection, the need for a separate CPU inside of the UUV is completely bypassed.

ii. UAV



Figure 5: UAV Top-Down Perspective

The UAV in Figure 5 uses a geofencing protocol to create an inclusion zone to maintain its positioning within the competition's boundary. Rather than waiting for UAV to recognize that is outside the geofence boundary, a safety buffer was implemented to ensure the UAV will remain inside the boundary. When approaching this safety buffer, the UAV's flight controller will activate its Return-to-Launch (RTL) protocol, and the UAV will navigate back to its original launch position. This allows for a simple and effective recovery of the UAV during testing and competition in case of various situations the UAV may experience. The UAV will also be able to switch from active flight mode to hover mode. This hover mode provides an immediate safety response while waiting for a new command or decision to be made.

iii. UUV



Figure 6: Grounded UUV

Utilizing image capture and a wired connection to the USV, the team's UUV, shown in Figure 6, is able to navigate using similar logic to the USV. The platform used is the Blue Robotics Blue ROV2, which includes a barometer, internal compass, and a camera, which has been turned into its primary form of navigation. Rather than LiDAR, the sub's main form of vision, a combination of the onboard 1080p camera and YOLO, creates a dynamic course correction and color recognition system. By using image capture for navigation, the sub can recognize bodies like the LiDAR, but with the added benefit of distinguishing colors. For the pipeline task, both are required, which meant that this form of navigation became the most cost-effective when selection processes began. With the connection to the USV, the sub can send photographs of its immediate line of site, and with the Jetson, YOLO image detection software can be run, without the need for a separate CPU for the UUV. Image detection models are created in Roboflow [9], an online resource which allows users to upload images and through AI, create a detection model with the added use of utilizing a self-hosted API. This negates the need to heavily utilize WiFi, with a process flow shown in Figure 7, a detection logic created in Roboflow.

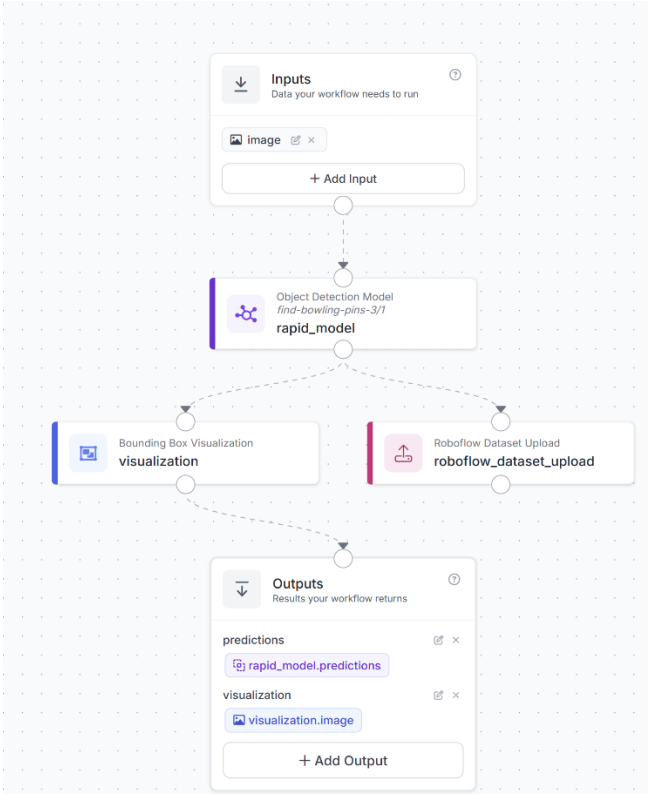


Figure 7: Roboflow Image Detection Logic

Using AI models and the detection logic of YOLO, Roboflow can capture and label data for use in training and testing, with the ability to manually annotate the data as well. In addition, by having a wired connection, the sub can reference its position relative to the boat, which means that GPS navigation, a challenging form of navigation to use underwater, becomes more plausible. By using swarming logic, both vehicles maintain the ability to communicate positions within the course. Through the combination of the three vehicles, local positions, obstacles, and guidance can be provided, from the air, surface of the water, and below water.

V. Acknowledgements

Bayou Bot Krewe would like to thank Yasmeen, Qudsi, John Carroll, and Dr. Jonathan R. Rausch for their support and guidance throughout the duration of this project. We would also like to acknowledge the University of Louisiana at Lafayette for providing resources and facility space, and additionally Blue Robotics for providing their robotic platforms and resources that supported the team's development. We would also like to thank Red Lerille's Health and Racquet Club for providing outdoor and indoor testing space for aquatic vehicles. We thank the RobotX competition crew and other members of RoboNation for hosting the competition and providing feedback for submissions, as well as guidance for physical and software modifications. We would also like to thank Chance Maritime, a major contributor to guiding UUV construction. We are also very grateful to Saronic Technologies for their support of our program, and resources provided by their team.

VI. References

[1] Cepeda, M. F. S., Machado, M. S. F., Barbosa, F. H. S., et al. (2023). Exploring autonomous and remotely operated vehicles in offshore structure inspections. Journal of Marine Science and Engineering.

[2] 1 robotx 2026 | team handbook, https://robonation.org/app/uploads/sites/2/2025/10/TeamHandbook_RobotX-2026-20260330.pdf (accessed May 4, 2026).

[3] J. Redmon and A. Farhadi, "YOLOv3: An Incremental Improvement," Yolo: Real-time object detection, https://pjreddie.com/darknet/yolo/ (accessed Mar. 19, 2026).

[4] "Overview," BlueOS Documentation, https://blueos.cloud/docs/stable/usage/overview/

[5] "ROS 2 Humble Hawksbill Documentation," ROS Documentation, https://docs.ros.org/en/humble/index.html

[6] "ArduPilot Sub Documentation," ArduPilot Documentation, https://ardupilot.org/sub/

[7] "QGroundControl Features and Configuration," ArduSub Documentation, https://www.ardusub.com/reference/qgc-configuration.html

[8] "RobotX 2026 Competition Primer & Task Ideas," RoboNation, https://robonation.org/app/uploads/sites/2/2025/11/Competition-Primer_RobotX-26.pdf

[9] "Computer Vision Tools for developers and enterprises," Roboflow, https://roboflow.com/ (accessed Sep. 28, 2026).

Appendix A: Component List

TABLE I: Bayou Bot Krewe USV Components

Part	Vendor	Model/Type	Specs	Cost	Year of Purchase
ASV Hull Form/ Platform	Blue Robotics	BlueBoat	Twin-Hull USV, lxwxh: 1195mm x 910mm x 376mm	$4,400	2026
Propulsion	Blue Robotics	M200 Motors	4.4 in. prop diameter 12V @ 17 Amps, 470 RPM/V	Included in platform	2026
Power System	MaxAmps	MA-1700-1S	4 x 3.7V, 1700 mAh, 1s 15c 62.9 Wh	$1,376	2026
Motor Controls	Blue Robotics	Basic ESC 500 – BlueBoat Configuration	Bidirectional ESC, 5V@4A, PWM range: 1100 microsecond - 1900 microsecond	Included in platform	2026
CPU	Nvdia	Jetson Orin Nano	1.7 GHz CPU frequency and 102 GB/s Memory Bandwidth	$672.99	2026
Teleoperation	Xbox	XBox Wireless Controller	Bluetooth enabled wireless controller	$70.00	2026
Compass	Blue Robotics	MMC5983	3V, 18 bit resolution magnetometer	Included in platform	2026
Compass	Blue Robotics	AK09915	3 V 16-bit resolution, x,y,z plane	Included in Platform	2026

Inertial Measurement Unit (IMU)	Blue Robotics	ICM-20602	6-axis / 6-DOF IMU with accelerometer and gyroscope	Included in platform	2026
Algorithms	Custom	Perception Node	Detects objects/buoys, gates, and calculates centerpoints	N/A	N/A
Localization and Mapping	3DR	GPS u-Blox Neo-M9N - IST8308	4.5-5.5V op range @20mA with USB compatibility	Included in Platform	2026
Vision	Unitree Robotics	Unitree 4D LiDAR L2	30 m. range with 360° x 96° FOV	$419.00	2026
Autonomy	Ardupilot	v.4.7.1 (latest release)	Free piloting software with variable direction command format	N/A	N/A
Open Source Software	ROS	Rviz	Used to visualize LiDAR/perception information	N/A	N/A

TABLE II: Bayou Bot Krewe UUV Components

Part	Vendor	Model/Type	Specs	Cost	Year of Purchase
Frame	Blue Robotics	Blue ROV2 Heavy Kit	18x13.3x10 in. 100 meter depth rating	$5,800	2025
Buoyancy Control	Blue Robotics	R-3318 Polyurethane foam	Density of 288 kg/m^3 and depth rating of 300 meters	Included in Frame	2025
Buoyancy Control	Blue Robotics	Stainless Steel Ballast Weight	300 grams, 3 total	Included in Frame	2025
Waterproof Housing	Blue Robotics	Acrylic Watertight Enclosures	100 meter depth rating; separate battery enclosure	Included in Frame	2025
Waterproof Connectors	Blue Robotics	WetLink Penetrators	18 x M10	Included in Frame	2025
Thrusters	Blue Robotics	T200 Thrusters	minimum thrust 0.05 kgf, max thrust (FWD/REV) @ 16V 5.25/4.1 kgf	Included in Frame	2025
Motor Control	Blue Robotics	Basic 30A ESC	7-26 V (2-6s) @30A, PWM Range: 1100 microsecond - 1900 microsecond	Included in Frame	2025
High Level Control	Linux	QGroundControl	Controls manual input and direction through Ardusub Firmware	Open Source	N/A

Propellers	Blue Robotics	T200 Propellers	3.9 in. prop, clockwise and counterclockwise	Included in Frame	2025
Battery	MaxAmps	MA-1700-1S	3.4 V LiPo Battery (2 connected in series)	$688	2026
CPU	Nvidia	Jetson Orin Nano	1.7 GHz CPU frequency and 102 GB/s Memory Bandwidth	Part of USV	2026
Internal Comm Network	Raspberry Pi Foundation	Raspberry Pi 4 (2 GB)	Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz	Included in Frame	2025
External Comm Interface	Blue Robotics	Fathom ROV Tether / Fathom-X	50 m tether for hard-wire USV & UUV Connection	$420	2025
Compass	Blue Robotics	Navigator	Dual 3-DOF Magnetometers	Included in Frame	2025
Inertial Measurement Unit (IMU)	Blue Robotics	Navigator	6-DOF IMU	Included in Frame	2025
Algorithms	Custom	Image Nav	Uses YOLO to detect color and open CV to define normalized centerpoint to navigate to	N/A	N/A
Vision	Blue Robotics	Low-Light HD USB Camera	1080p camera, 110° underwater FOV, 0.01 lux; 2 Lumen Subsea Lights	$385	2025

Localization and Mapping	3DR	GPS u-Blox Neo-M9N – IST8308	Connection to USV	N/A	N/A
Autonomy	Blue Robotics	Ardusub	Version 4.7.1 (latest release) handles dynamic movement control through communication with ROS packages	N/A	N/A
Open Source Software	ROS	ROS2	Used to manage vehicle behavior from camera intelligence	N/A	N/A
Inter-Vehicle Communication	Blue Robotics	BlueBoat BaseStation	802.11a/b/g/n (2412 - 2462MHz); 7 dbi antenna; signal attenuated to 20 dBm	$580	2025
Programming Language (s)	Python	Python (latest release)	Open-source onboard operating and vehicle-control software	Open-Source	N/A

Table III: Bayou Bot Krewe UAV Components

Part	Vendor	Model/Type	Specs	Cost	Year of Purchase
Frame	DJI	F450	450 mm quadcopter footprint; main UAV frame structure	$72	2021
Frame	ULL CRAWLab	Carbon Fiber Breakout Board	Carbon-fiber plates used for reinforcement and mounting electronics	$75	2021
Computer	Raspberry Pi	Raspberry Pi 4 Model B	8 GB RAM; Quad-core 64-bit ARM Cortex-A72 CPU at 1.5 GHz; Wi-Fi; Bluetooth; Gigabit Ethernet; USB 3.0/2.0; dual micro-HDMI; GPIO; CSI camera interface; microSD storage.	$90	2021
Motors	EMAX	MT2213	935 KV; approx. 860 g thrust; used with 1045 propeller	$268	2021
Propellers	EMAX	1045	10 × 4.5 in propeller; CW/CCW configuration	w/ motors	2021
Motor Control	Readytosky	40A Brushless ESC, 4-Pack	2–4S input, 40 A ESC, 5 V/3 A BEC; designed for F450/S500/ZD550 quadcopters	$80	2026
Flight Controller	Holybro	PX4 FMU / Pixhawk 4	5 V; dual accelerometer/gyro; onboard barometer	$245	2021
Companion Computer	Raspberry Pi	Raspberry Pi 4 Model B	ARMv8, 1.5 GHz; 8 GB DDR4 RAM	$90	2021

RTK GPS	SparkFun	GPS-RTK Board	NEO-M8P-2; 5 Hz RTK; 5 V, 35 mA	$199.95	2021
RTK GPS Antenna	SparkFun	GPS/GNSS Embedded Antenna – 1m (SMA), GPS-14987	GPS L1 / GLONASS L1 / BeiDou B2; 38 dB LNA; SMA; 1 m cable; 45 g	$95.95	2021
Altitude Sensor	Garmin	LiDAR-Lite V3HP	1–40 m range; 5 V; 85 mA; downward-facing	$150.00	2021
Vision Camera	Luxonis	OAK-D Stereo Camera	1280×800; up to 120 FPS; depth + RGB sensing; 5 V	N/A	2021
Battery	Spektrum	SPMX22003 S50 Smart LiPo	2200 mAh, 3S, 11.1 V, 50C, IC3 connector, 24.42 Wh	$34.99	2026
Autonomy	ArduPilot	ArduCopter v4.7.1	Autopilot software for navigation, flight modes, geofencing	Open Source	N/A
Open Source Software	ROS	Rviz	Process management and creation of movement and vision packages	Open Source	N/A

Appendix B: USV Control Box

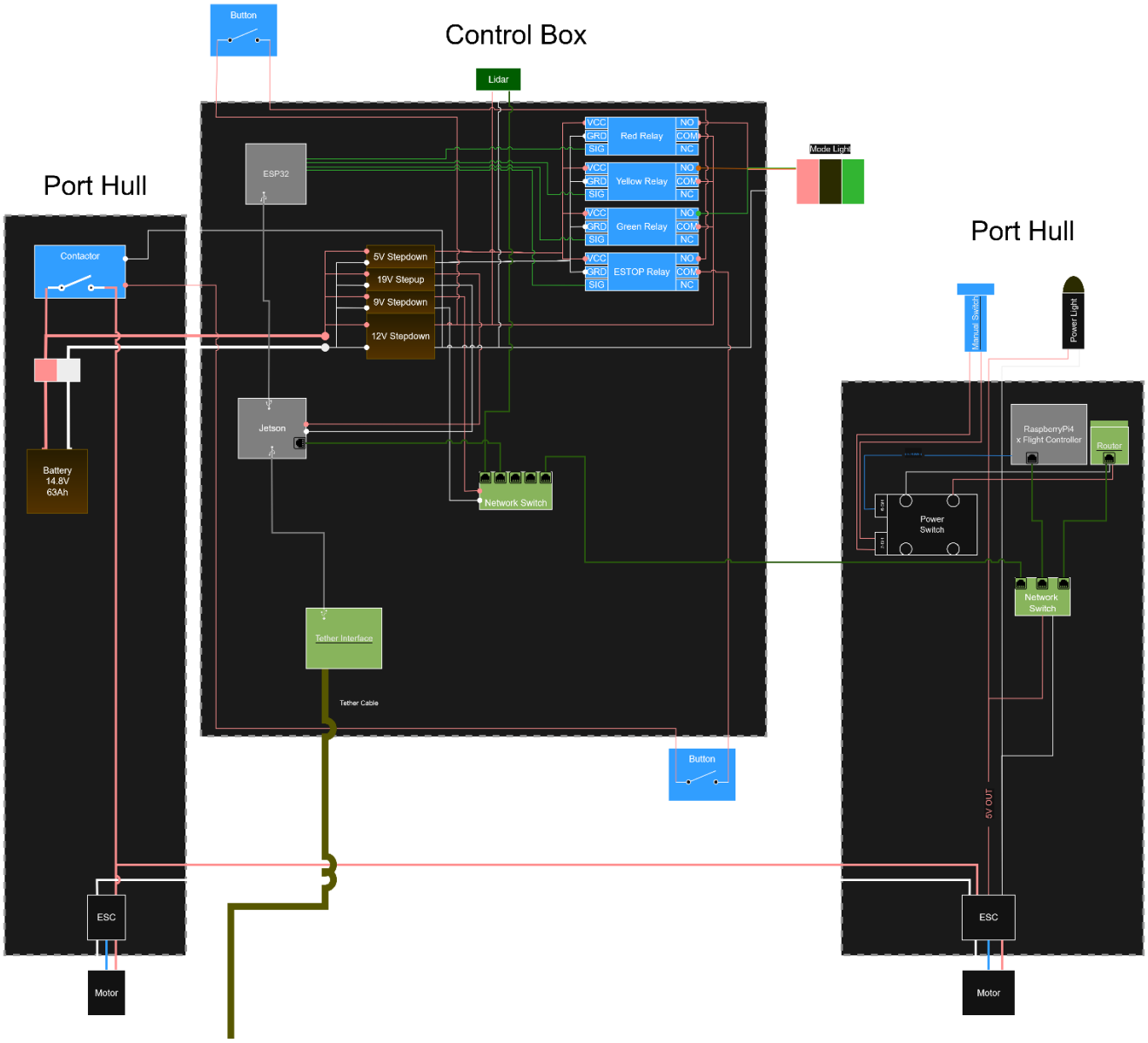


Figure 1: USV Electrical Diagram

I. Control Box Purpose

The above pictured diagram contains a full outline of all electrical systems in the USV. The purpose of the box is to fully integrate the existing architecture of the BlueBoat while allowing for further modifications and implementation of autonomous systems. The box powers all autonomous modules for all systems, with direct wired communication between the USV and UUV, and a wireless connection through the BaseStation to the UAV. By centralizing all communications and autonomous decision-

making to one vehicle. The process of communication is simplified, as now all processes can be run through a centralized control unit.

II. Inter-Vehicle Communications

All vision systems are run through the Jetson Orin Nano, the onboard computer powering the 3 three autonomous vehicles. The Jetson is a mini computer running at a 1.7 GHz CPU frequency and 102 GB/s Memory Bandwidth. Weight on the UAV is a serious issue, and space for additional electronic components is very limited within the UUV, so by running all communications through one unit in the largest and most easily accessible system, both cost and total weight are reduced. By having a single brain, information can be shared between devices more reliably, and without a WiFi connection required. The BaseStation provides its own local network, so by connecting all vehicles and a laptop to the BaseStation, no external communication software is necessary.

III. Process Execution

Through image processing technology in a combination of Roboflow and Python, image recognition is possible through the Jetson for both the UAV and the UUV. By first uploading images or video of an aerial view of the course, the USV through the Jetson is capable of annotating the feed and then processing as directional data based on the position of the UAV. Once completed, the map created from UAV footage can then be developed into navigable GPS coordinates for the USV, which in turn uses LiDAR, run through ROS packages in the Jetson, to navigate identifiable obstacles. By having a hard-wired connection to the USV, the UUV can use the boat as a reference point, and by running a similar image detection to the UAV, locate and navigate to mission objectives. By using the centralized control box, all processes can be monitored using a single connection to the BaseStation through a laptop, where a GUI has been created with individual windows for all 3 systems, as well as Robocommand output for the competition. The system runs on 4 LiPo batteries connected in series, and utilizes an ESP32 and onboard electronics for the BlueBoat, as what was listed in Appendix A.