

# Team Katrina: Technical Design Report

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## I. Abstract

Team Katrina's 2026 RoboBoat entry builds upon an existing autonomous surface vessel platform, with a primary focus on improving the vessel's control system and autonomy performance to meet the requirements of the RoboBoat Competition. The established mechanical platform was retained, allowing design efforts to concentrate on control architecture, sensor integration, and system reliability. The vessel utilizes a catamaran style hull and a four-thruster propulsion configuration to provide precise maneuverability. A distributed control system consisting of a Raspberry Pi, ESP32, and Jetson Nano enables multi-node processing and real time coordination between subsystems. Integrated GPS, LiDAR, and camera sensors support autonomous navigation, waypoint tracking, and obstacle detection. The system operates in both autonomous and remote-controlled modes, allowing for human intervention to ensure safe operation. This report presents the vessel's existing mechanical platform alongside the updated control system design, integration approach, and testing methods used to validate overall performance.

### ACRONYMS AND ABBREVIATIONS

ASV	Autonomous Surface Vehicle
ESC	Electronic Speed Controller
DOF	Degree-of-Freedom
ROS2	Robot Operating System 2
IMU	Inertial Measurement Unit
GPS	Global Positioning System
TAM	Thruster Allocation Matrix
OCS	Operator Control Station

## II. Technical Content

### A. Competition Strategy

For the 2026 RoboBoat Competition, Team Katrina focused on improving the existing autonomous surface vessel, shown in Figure 1, to better meet competition requirements. Based on the six assigned mission tasks, design efforts were concentrated on

completing the evacuation route (Task 1), performing debris clearance (Task 2), emergency response sprint (Task 3), and navigating the marina (Task 5). This decision was based on the vessel's existing operational capabilities. While the platform already supported autonomous operation, its performance was limited, making control system improvements the primary focus of this project. Rather than integrating additional mechanical components to complete a supply drop (Task 4) and Harbor Alert (Task 6), efforts were directed toward enhancing the functionality and reliability of the existing vessel. A networking system will be established to enable communication with the judges for each task.

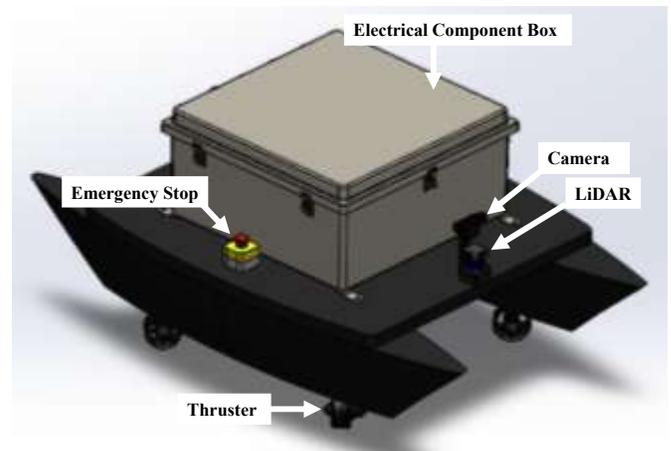


Figure 1: Model of Team Katrina's ASV

### B. Task Execution

Katrina integrates multiple sensors to process information and execute tasks. These sensors include LiDAR and cameras, which are critical for object detection. In conjunction, a dual antenna GPS provides positional and orientation data of the ASV, together allowing detected objects to be accurately located. Based on this information, the system performs decision-making to determine a route which enables the ASV to avoid obstacles while remaining on course.

#### a) Evacuation Route (Task 1)

The objective of the evacuation route task is for the ASV to navigate safely through entry and exit gates,

each marked by a pair of red and green buoys. Using its vision and navigation systems, the ASV will identify the gates and follow the path in between them to successfully complete the task.

#### ***b) Debris Clearance (Task 2)***

In the Debris Clearance task, the ASV must navigate through a channel marked by red and green buoys, while avoiding black buoys that represent debris. Similar to Task 1, the ASV will use its camera, LiDAR, and GPS to stay within the channel, while also detecting the location of the debris to plot a safe path around it. This task requires the ASV to have reliable and accurate decision-making capabilities.

#### ***c) Emergency Response Sprint (Task 3)***

In Task 3, the Emergency Response Sprint, the ASV must navigate through a series of gates and focus on a yellow buoy located after the gates. The yellow buoy will display a red or green signal on top. The ASV needs to identify the color of the signal and respond accordingly. If the signal is green, the ASV must circle the buoy from the left side; if the signal is red, the ASV must circle from the right side. There will be debris in the paths, and the ASV must continue to avoid the debris.

#### ***d) Navigate the Marina (Task 5)***

To Navigate the Marina, the ASV will enter the docking location and dock in an open space. Each dock will have an assigned number, and a red or green sign. The sign will indicate if the dock is occupied (red) or unoccupied (green). The goal is for the ASV to dock in an unoccupied space with the lowest number sign available. This task requires consistency and accuracy of the vision system.

### **III. Design Strategy**

#### ***A. Mechanical Design***

The body design of Katrina has a catamaran-style hull configuration, which enhances overall stability and reduces unwanted motion in calm and moderately disturbed water conditions. The hulls are constructed from foam-filled fiberglass, providing a lightweight structure while maintaining high buoyancy. This design ensures positive buoyancy is retained even in the event of hull damage. This hull offers a wide deck area for mounting onboard electronics and sensors while maintaining a low center of gravity. Dimensions of

the ASV and the calculated tipping angle are shown in Appendix A. Team Katrina conducted stability calculations to determine the ASV's tipping angle, ensuring it can operate without capsizing. These calculations are shown in Appendix B.

#### ***B. Propulsion***

The ASV is equipped with four Blue Robotics T-200 thrusters mounted to the hulls, with two thrusters installed on each hull. Each thruster is controlled by an independent electronic speed controller (ESC). The ESCs communicate through an ESP32 micro-controller, enabling real-time command and control of the propulsion system. For manual operation, a Radio Master TX16S transmitter communicates wirelessly with a Radio Master RP3 receiver mounted inside the waterproof enclosure on the hull. The receiver interfaces a microcontroller, which processes the operator's inputs and commands the propulsion system accordingly. Through the transmitter, the operator maintains full control of the ASV and can switch the ASV between remote and autonomous modes. For safety, an emergency stop function is accessible from the transmitter that can be used by the operator to disable power to the propulsion system from the ASV when required. In addition, if the transmitter loses power or its connection to the receiver, two onboard emergency stops are available on the ASV.

#### ***a) Holonomic Motion***

The RoboBoat utilizes a quad thruster configuration with each thruster mounted at a  $\pm 45^\circ$  relative to the forward axis of the vessel which is shown in Figure 2. This arrangement provides the ASV with holonomic motion, allowing the boat to surge (forward/backward) and sway (left/right) while simultaneously generating yaw rotation. This capability is essential for fast avoidance maneuvers and precise positioning, allowing the vessel to react immediately to obstacles detected by onboard sensors.

To evaluate and verify this capability, a Thruster Allocation Matrix (TAM) was developed to quantify how each thruster contributes to the boat's motion in the body-frame coordinate system. The TAM relates desired motion commands – surge velocity "x", sway velocity "y", and yaw rate " $\omega$ " – to the individual thruster outputs required from all

four motors. By inverting this matrix, the control system can compute the exact thrust values needed to achieve any commanded velocity vector. This analysis confirmed that the chosen thruster geometry provides full holonomic maneuverability, adequate yaw authority, and balanced force distribution across the vessel. All calculations, thruster geometry diagrams, and the complete TAM derivation are provided in Appendix C.

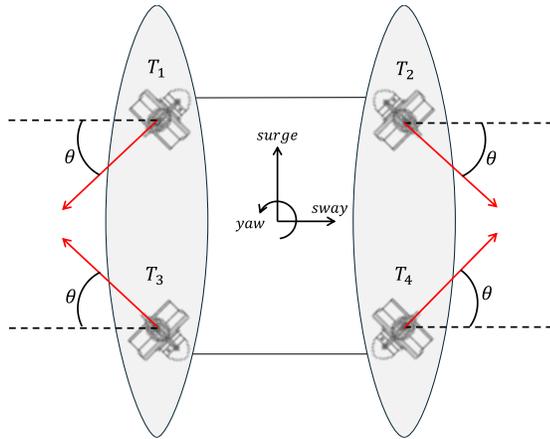


Figure 2: Holonomic Motion & Thruster Orientation

### C. Electrical and Power System

The ASV contains a sealed, waterproof electrical enclosure that houses all electronic components and protects them from water. With limited organization and the lack of wiring protection, Team Katrina’s priority was to document the existing electrical system by creating a detailed wiring diagram. The electrical enclosure was reorganized to implement structured wire routing and improve cable management, reducing strain on connections and improving overall reliability. Additionally, mounts were created for the microcontroller, Raspberry Pi, Jetson Nano, batteries, GPS, and power buses to improve organization, allow easy access, and secure components.

Team Katrina upgraded the Arduino Nano microcontroller, the GPS, the signal light, and integrated new components including an ESP32, Raspberry Pi 4, Jetson Nano, OAK-D cameras, LiDAR sensors, a dual-antenna GPS, and a router, while keeping the existing thrusters. These upgrades increased the overall power demand, resulting in an insufficient current supply and a noticeable reduction in the ASV’s runtime.

As a result, the overall power consumption was analyzed with the thrusters operating at 75% throttle and all components in the system. The existing system was powered by two 12 V, 7 Ah connected in parallel. With the existing batteries, the system provided 14 amp-hours, limiting the ASV to approximately 15 minutes of runtime. This runtime was insufficient to meet operational requirements, which led the team to upgrade to two 12 V, 14 Ah batteries which increases the capacity to 28 Ah. This upgrade allows for a runtime of approximately 30 minutes. The power consumption analysis is presented in Appendix D.

This power system was sized to support the increased electrical load while also providing substantial capacity headroom for future system upgrades which reduces concerns regarding battery life and capacity for future teams.

The wiring diagram of the electrical system is shown in Appendix E.

### D. System Architecture

The primary objective for Team Katrina was to improve the existing ASV’s control system. The previous team’s system relied on an Arduino Nano microcontroller with limited onboard components, which limited the performance of the ASV during competition. For the 2026 competition, Team Katrina decided to use an ESP32, Raspberry Pi 4, and a Jetson Orin Nano. Together, these subsystems communicate using ROS2 which allows for autonomous navigation and decision making. Figure 3 shows the path of communication between the computing subsystems.

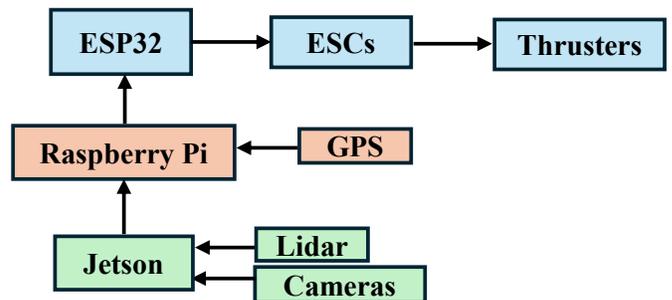


Figure 3: System Communication

#### a) ESP32

The ESP32 is dedicated to controlling thrusters through the ESCs and receiver, supporting both manual and autonomous modes of operation. In

manual mode, an operator uses a transmitter to control the ASV, with the ability to switch to autonomous mode when needed. When this switch occurs, the ESP32 begins receiving and commands from the Raspberry Pi and Jetson Nano.

#### ***b) Raspberry Pi 4***

The addition of the Raspberry Pi has been critical to the ASV's success. It supports the operations of the GPS which is essential for achieving autonomous navigation. The ASV utilizes a SparkFun Quadband GNSS [2] system capable of determining both the vehicle's position and heading while stationary as well as in motion. Because the ASV is manually driven to the start of each task, it is critical that the system accurately determines heading while the vehicle is stationary prior to switching into autonomous operation. In ROS2, a communication bridge was established to allow navigation commands generated by the Raspberry Pi to be transmitted to the ESP32, where they are executed through direct control of the thrusters.

#### ***c) Jetson Orin Nano***

Another addition to the existing ASV was a NVIDIA Jetson Orin Nano which is designed for artificial intelligence and machine learning applications. This addition enables processing vision and sensor data. Two OAK-D stereo cameras are connected to the Jetson to enable object identification. When an object is detected and identified, the Jetson processes the data to estimate depth and compute the object's relative angle and distance with respect to the ASV.

In addition to the cameras, the ASV is equipped with two LiDAR sensors that are connected to the Jetson. The LiDARs use a laser to measure distances to surrounding objects within a defined range, creating real-time information about the ASV's environment. By interfacing these sensors and using ROS2, detected objects can be converted into coordinate-based positions using GPS derived position and heading information. This sensor fusion enables the ASV to make informed navigation decisions and follow the appropriate path during autonomous operation.

#### ***E. Graphical User Interface and Network***

From the shore, the team can monitor the real-time status of every onboard component via a Foxglove interface that connects directly to ROS 2. To support this, a dedicated network system needs to be

set up. Through a laptop, the team connects to the vessel's network, allowing operators to access live camera feeds, positional data, heading and location information, and LiDAR sensor outputs in real time. Additionally, the networking system is crucial due to the extra task in this year's competition, which includes a required heartbeat task at the beginning of each mission. The team will link a computer acting as the OCS to the RoboCommand System, allowing judges to receive live status updates while the ASV is in operation.

### **IV. TESTING STRATEGY**

Since this year's team had not previously worked with the existing ASV, testing comprised a significant portion of the project timeline. This process allowed the team to become familiar with the capabilities and functionality of the existing sensors and components. Each component was individually bench tested prior to installation and system integration. Once bench testing was completed, integration was performed in stages, with each stage undergoing dry testing followed by on-water testing.

#### ***A. Bench Testing***

Bench testing was conducted on all existing and newly added components to verify proper functionality and to identify and resolve issues prior to full system integration.

##### ***a) Thruster Orientation***

The first approach to testing was focused on the thrusters. Because the thrusters provide holonomic motion and a new transmitter-receiver system was being implemented, it was important to fully understand their behavior and determine how they would be integrated into the control software. Initially, the remote control was configured to match the setup used by the previous team. The motion of each thruster was then verified using a bucket of water. Its thrusters' behavior was recorded when undergoing sway, yaw, and surge motions. From the recording of their behavior, the thruster direction matrix was corrected, ensuring that all thrusters responded properly to control commands.

##### ***b) Camera Testing***

Katrina is equipped with two OAK-D stereo cameras that form the core of the vision system. The

cameras were streamed through a DepthAI-based web graphical interface hosted on the Jetson's local IP address for bench testing. The vision system was trained to identify competition specific objects required for task completion. For each video frame, the interface displays a neural network bounding box around detected buoys, identifies their centroids, and computes both distance and relative angle from the camera. This configuration was used to validate the vision system's ability to consistently detect buoy locations, accurately estimate distances, and provide reliable positional data prior to integrating the information into autonomous navigation.

#### *c) Lidar Testing*

The ASV includes two LiDAR sensors mounted on the hull to provide obstacle detection and situational awareness. The testing was performed using a software tool called URG Benri, which allows real-time visualization of distance measurements and detected objects.

#### *d) GPS and IMU Testing.*

Using a NEO-M8P GPS module, the system was connected to a Raspberry Pi 4. The accuracy of the GPS and the ability to record a route was verified prior to integration using a vehicle. While the GPS consistently received satellite signals, determining an accurate heading was challenging. Initially, the team implemented a 6-DOF IMU and a magnetometer, which were fused using ROS2. The intent was to combine the resulting orientation data with GPS measurements to obtain a reliable heading while the vehicle was stationary. However, due to the complexity of sensor fusion and the accumulation of errors, the team transitioned to a 9-DOF IMU. During bench testing, the combined GPS and IMU system produced excellent results. However, once installed inside the ASV's electrical enclosure, significant magnetic distortion was observed. This interference was caused by the magnetometer's proximity to the ESCs and other electronic components. As a result, the team decided to upgrade to a dual-antenna GPS system. This solution eliminates magnetometer distortion and provides reliable heading information when the ASV is stationary.

### *B. Dry Testing*

To begin system integration and testing, the team first integrated the GPS with the ASV's thrusters as an initial step toward achieving autonomy. Using ROS2, a communication bridge was established between the Raspberry Pi and the ESP32, and autonomy nodes were developed. For this test, a walkable GPS coordinate was recorded and programmed into the system as a target location.

The ASV remained on its transport cart to allow for controlled testing and easy repositioning. The test procedure was straightforward: the ASV was powered on in manual mode, and once autonomy mode was enabled by the operator, the ASV was manually pulled toward the recorded GPS coordinate. Upon reaching the target location, the thrusters automatically stopped. This test marked a significant milestone, as it demonstrated the system's ability to recognize a target coordinate, navigate toward it, and successfully stop motion upon arrival.

Dry testing continued as additional sensors were integrated into the system. For camera validation, buoys were placed on land and the ASV was manually pulled by team members to evaluate its ability to detect and navigate between them. This test also incorporated GPS data, which was communicated to the vision system to determine position and support navigation decision-making. A similar testing approach was used for the integration and validation of the LiDAR sensors.

### *C. Water Testing*

Through integration stages, water tests were conducted. The initial water test focused on validating the remote-control capabilities. With only the minimum required components installed, the team confirmed that the vessel could be fully controlled by an operator and that the emergency stop feature on the controller could reliably and completely cut power to the ASV when activated.

Next, the GPS was integrated and waypoint navigation was tested. During this test, the team manually drove the ASV to several points on the water, recording their GPS coordinates, before returning the vessel to its starting position. When the operator enabled autonomous mode, the ASV

successfully followed the recorded path using the stored GPS waypoints.

The test following involved integrating the cameras and LiDAR sensors. Using red and green buoys representative of those used in competition, the ASV was tasked with autonomously navigating between the buoys.

Water testing will continue through the competition period. The team will focus on validating each planned task to ensure the ASV is fully capable of completing mission objectives.



*Figure 4: Team Katrina performing on-water testing*

#### **D. Simulator Testing**

The ROS2 based simulation uses Ignition Gazebo to create a baseline maritime environment for the ASV development and testing. The environment is built around a large static water plane, providing a controlled and uniform surface for evaluating object interaction and scene behavior prior to adding full hydrodynamic effects. Several simple geometric models, capsules, and a box are placed across the environment to act as stand-ins for navigational markers, obstacles, or reference points for future perception and control tasks. Successfully launching this environment verifies that the package structure, configuration, and Ignition Gazebo interface are functioning correctly on the Jetson platform. The simulation establishes the foundational framework needed for adding buoyancy, thruster dynamics, onboard sensor models, and autonomous navigation algorithms in subsequent development phases.

#### **V. CONCLUSION**

In preparation for the RoboBoat 2026 competition, Team Katrina has enhanced its vessel with several key upgrades, including adding cameras, LiDARs, an upgraded GPS, new batteries, a signal light, a new transmitter/receiver, an ESP32, a Jetson Nano, and a Raspberry Pi 4. These upgrades significantly improve the vessel's autonomy and overall performance. Team Katrina also established a networking system on the vessel for integration and data communication. The components were integrated through ROS2, which provided a reliable and efficient control system for the vessel. Team Katrina completed several water tests to confirm proper ASV operation and make adjustments as needed. With the improvements and upgrades, Team Katrina's goal for the 2026 competition is to successfully complete all tasks except for the supply drop. The progress made by this year's team sets a strong foundation for future teams, allowing them to focus on the mechanical enhancements required for the supply drop task or any new challenges introduced by RoboNation in future competitions.

#### **VI. ACKNOWLEDGEMENTS**

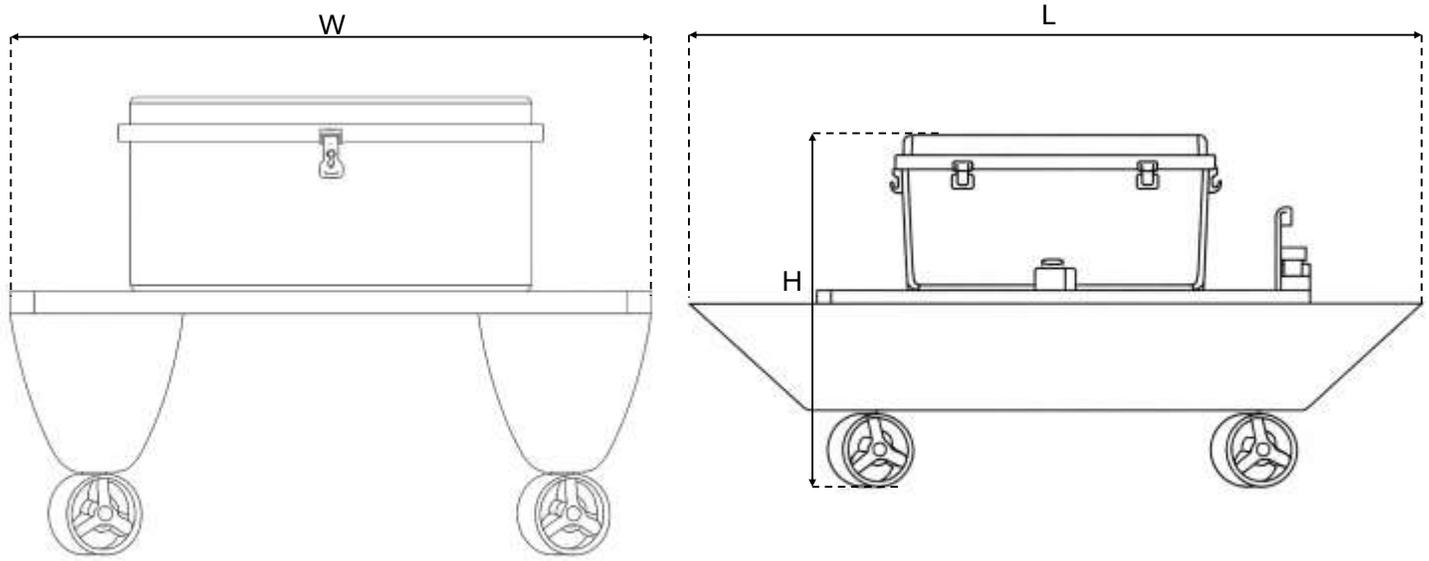
Team Katrina extends its heartfelt thanks to Acadiana Lawn and Cycle, Atmos Energy, Chapman Consulting, Donald W. Barnes Jr, MD, and Welborn & Hargett Injury Attorneys who contributed to making this project possible. Along with the listed businesses, we would like to thank our family and friends who made donations to our team. We also express our gratitude to the Department of Mechanical Engineering and alumni from previous teams at the University of Louisiana at Lafayette for their support, resources, and technical advice.

We would like to recognize the guidance of our faculty advisor Ms. Yasmeeen Qudsi. Finally, we are grateful to RoboNation for providing us with the opportunity to compete in the RoboBoat Competition.

## REFERENCES

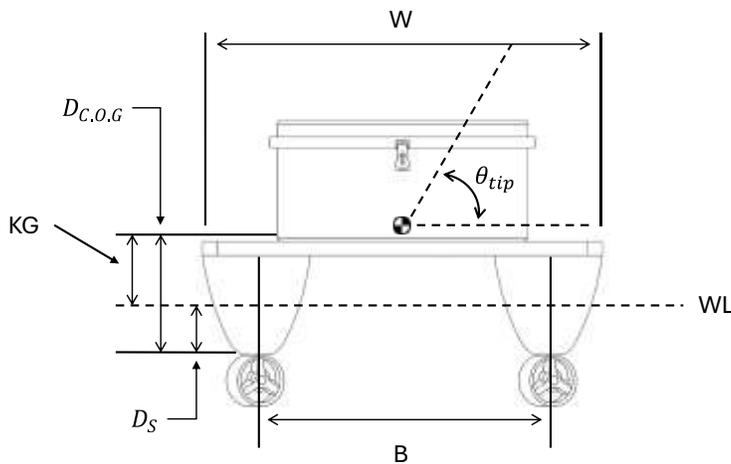
- [1] ROBOBOAT. (2026). ROBOBOAT 2026. [HTTPS://ROBOBOAT.ORG/PROGRAMS/2026/](https://roboboat.org/programs/2026/)
- [2] “Code of ethics: National society of professional engineers,” Code of Ethics | National Society of Professional Engineers [Online]. Available: <https://www.nspe.org/career-growth/ethics/code-ethics>.
- [3] Marks, L. J. (2024). High-fidelity dynamic modeling and trajectory-tracking control of an overactuated autonomous surface vessel. University of Louisiana at Lafayette.

## Appendix A: Hull Dimensions



<b>Dimensions</b>	
<b>Total Length (L)</b>	1.524m
<b>Total Width (W)</b>	0.825m
<b>Total Heigh (H)</b>	0.630m

## Appendix B: Tipping Angle



Where:

- $D_S$  = Hull Submerged Depth
- $D_{C.O.G}$  = Distance from COG to bottom of hull
- $W$  = Total Width
- $WL$  = Waterline
- $B$  = Hull center-to-center spacing
- $KG$  = COG height above waterline
- $\theta_{tip}$  = Roll angle at which the boat will capsize

$$D_{C.O.G} = 11 \text{ in} , D_S = 4.5 \text{ in}$$

The height of the COG above the waterline, commonly referred to as  $KG$ , was calculated by subtracting the submerged depth from the COG height:

$$KG = D_{C.O.G} - D_S = 11 - 4.5 = 6.5 \text{ in}$$

To determine the vessel's roll stability, the tipping angle was calculated. This requires knowing the horizontal distance from the centerline to the outer point of support. For the twin-hull configuration, the hull-to-hull spacing (center-to-center width) was measured as:

$$B = 23 \text{ in}$$

The tipping angle occurs when the vertical projection of the COG passes outside this support width. This angle is given by:

$$\theta_{tip} = \tan^{-1} \left( \frac{B/2}{KG} \right) = \tan^{-1} \left( \frac{23/2}{6.5} \right) = 60.52^\circ$$

## Appendix C: Thruster Orientation

### C.1 Thruster Geometry and Coordinate Definitions

- +X axis: forward (surge direction)
- +Y axis: starboard (sway direction)
- +Z axis: downward
- +Yaw: counterclockwise rotation about the Z-axis

### C.2 Thruster Allocation Matrix (TAM) Derivation

The RoboBoat has four thrusters located symmetrically relative to the center:

Thruster	Position (x,y)	Angle from +x
$T_1$	(+L,+W)	+45°
$T_2$	(-L,+W)	-45°
$T_3$	(-L,-W)	+45°
$T_4$	(+L,-W)	-45°

Where:

L = forward/backward distance from center

W = left/right distance from center

### C.3 Direction Vectors for Each Thruster

According to  $F_x = F\cos\theta$  and  $F_y = F\sin\theta$ , a thruster at an angle  $\theta$  contributes force in the x and y direction.

Since the angles are  $\pm 45^\circ$ , these values simplify to:  $\cos 45^\circ = \sin 45^\circ = \frac{\sqrt{2}}{2}$

So, each thruster produces:

$$\text{At } +45^\circ: F_x = \frac{\sqrt{2}}{2}F, F_y = \frac{\sqrt{2}}{2}F$$

$$\text{At } -45^\circ: F_x = \frac{\sqrt{2}}{2}F, F_y = -\frac{\sqrt{2}}{2}F$$

This generates mixed values for each thruster in the surge and sway directions.

## C.4 Yaw Moment Contribution

Each thruster generates a yaw moment due to its offset from the center.

Moment of each thruster:  $\tau = xF_y - yF_x$

Where:

- $x$  = thruster x – location
- $y$  = thruster y – location
- $F_x, F_y$  are from Section A.3

## C.5 Thruster Allocation Matrix (Complete TAM)

General Matrix form:

$$\begin{bmatrix} x \\ y \\ \omega \end{bmatrix} = \begin{bmatrix} \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \\ \frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \\ \frac{\tau}{F_1} & \frac{\tau}{F_2} & \frac{\tau}{F_3} & \frac{\tau}{F_4} \end{bmatrix} \begin{bmatrix} T_{FL} \\ T_{FR} \\ T_{RL} \\ T_{RR} \end{bmatrix}$$

Where:  $\frac{\tau}{F_i} = x_i \sin \theta_i - y_i \cos \theta_i$

## C.6 Pseudoinverse for Commanded Motion

To solve for thruster forces from a desired motion vector, transpose the M matrix:

$$\begin{bmatrix} T_{FL} \\ T_{FR} \\ T_{RL} \\ T_{RR} \end{bmatrix} = M^T \begin{bmatrix} x \\ y \\ \omega \end{bmatrix} \rightarrow \begin{aligned} T_{FL} &= +x + y - \omega \\ T_{FR} &= +x - y + \omega \\ T_{RL} &= -x + y + \omega \\ T_{RR} &= -x - y - \omega \end{aligned}$$

## Appendix D: Overall Power Consumption

### D.1 Power Consumption of Each Component

Each electrical component and its specifications were analyzed, and the power consumption of each was documented. Table D.1 lists all components.

<u>Component</u>	<u>Power (W)</u>
ESP32	1.7
Raspberry Pi	12.5
Lidar	24
Camera	10
GPS/IMU	1.25
Jetson	15
Signal Light	1
Router	1
Thrusters @ 75%	605.28
<b>Total</b>	<b>671.73W</b>

### D.2 Current and Usable Energy of Batteries

- **Two 12V, 7Ah Batteries**

Total Current:  $I_{total} = 2 \times 7Ah = \mathbf{14Ah}$

Total Usable Energy:  $P_{max} = I_{total}V = 14Ah * 12V = \mathbf{168Wh}$

- **Two 12V, 14Ah Batteries**

Total Current:  $I_{total} = 2 \times 14Ah = \mathbf{28Ah}$

Total Usable Energy:  $P_{max} = I_{total}V = 28Ah * 12V = \mathbf{336Wh}$

### D.3 Runtime Estimate

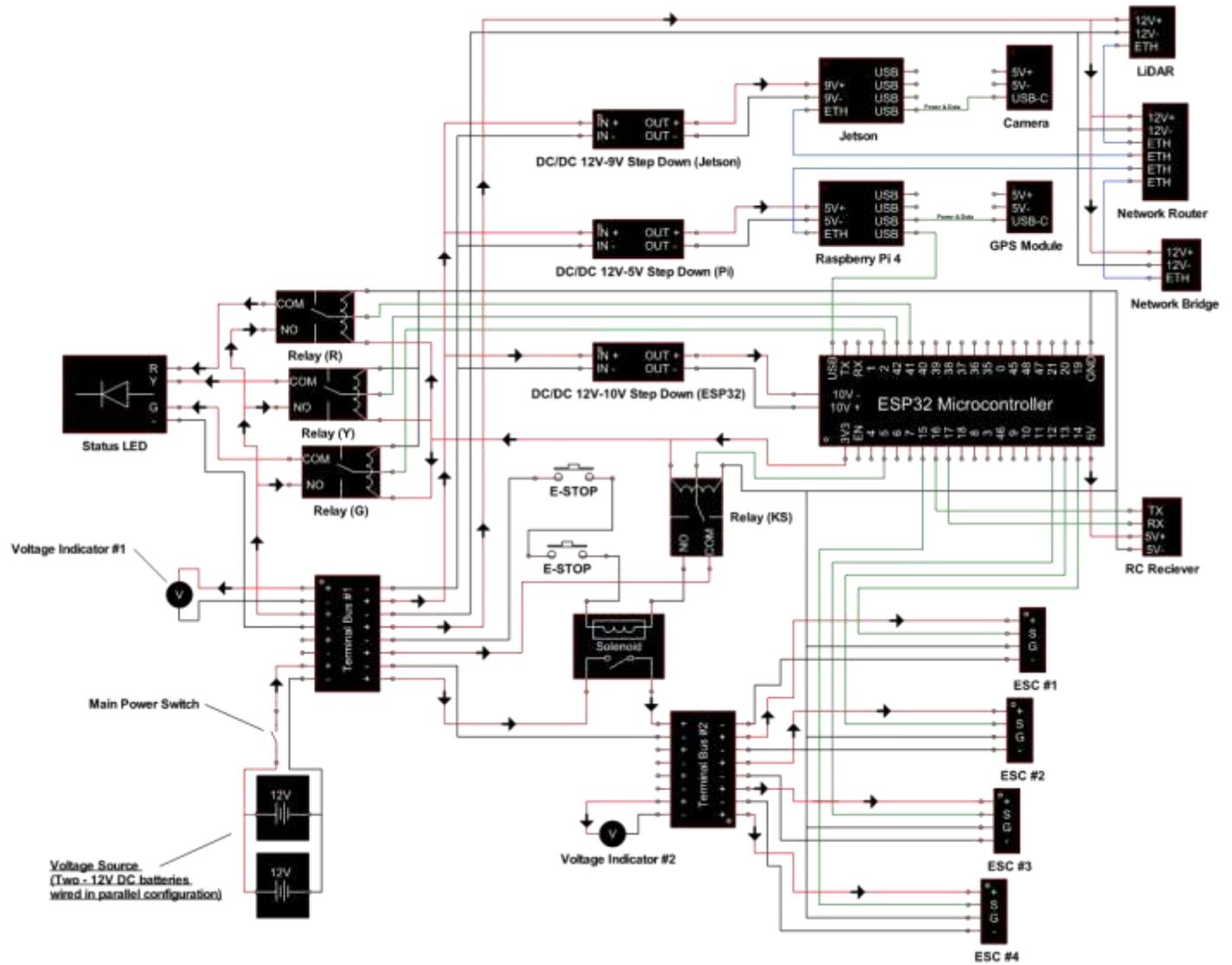
Runtime (Original Batteries):

$$t = \frac{P_{max}}{P_{used}} = \frac{168}{671.73} = 0.25 \text{ hours} = 15 \text{ minutes}$$

Runtime (Upgraded Batteries):

$$t = \frac{P_{max}}{P_{used}} = \frac{336}{671.73} = 0.5 \text{ hours} = 30 \text{ minutes}$$

# Appendix E: Electrical Diagram



The Electrical Diagram can also be found on our team website:

<https://sites.google.com/view/teamkatrinawebsite/our-boat/electrical-system?authuser=0>

## Appendix F: Component List

Component	Vendor	Cost (\$)	Website
<b>Thrusters (4)</b>	Blue Robotics	\$230	<a href="#">Click Here for Website</a>
<b>Motor Controllers (4)</b>	Blue Robotics	\$40	<a href="#">Click Here for Website</a>
<b>E-Stops (2)</b>	Baomain	\$10	<a href="#">Click Here for Website</a>
<b>ESP-32 Controller</b>	Freenove	\$20	<a href="#">Click Here for Website</a>
<b>ESP-32 Breakout Board</b>	Freenove	\$15	<a href="#">Click Here for Website</a>
<b>Raspberry Pi 4</b>	Raspberry Pi	\$64	<a href="#">Click Here for Website</a>
<b>Raspberry Pi Breakout Board</b>	HCDC	\$19	<a href="#">Click Here for Website</a>
<b>Raspberry Pi Fan</b>	GeekPi	\$19	<a href="#">Click Here for Website</a>
<b>Jetson Orin Nano</b>	NVIDIA	\$250	<a href="#">Click Here for Website</a>
<b>LiDAR (2)</b>	Hokuyo	\$1,000	<a href="#">Click Here for Website</a>
<b>Cameras (2)</b>	Luxonis Oak D	\$300	<a href="#">Click Here for Website</a>
<b>GPS Module</b>	SparkFun	\$250	<a href="#">Click Here for Website</a>
<b>Antenna (2)</b>	SparkFun	~\$70	<a href="#">Click Here for Website</a>
<b>WiFi/Network</b>	TP-Link	\$28	<a href="#">Click Here for Website</a>
<b>Network Bridge</b>	Reumar	\$65	<a href="#">Click Here for Website</a>
<b>Power Distribution Board (2)</b>	Powerwerx	\$40	<a href="#">Click Here for Website</a>
<b>Main Batteries (2)</b>	Duracell	\$71	<a href="#">Click Here for Website</a>
<b>LED Indicator</b>	LUBAN	\$20	<a href="#">Click Here for Website</a>
<b>Transmitter</b>	RadioMaster	\$300	<a href="#">Click Here for Website</a>
<b>Receiver</b>	RadioMaster	\$105	<a href="#">Click Here for Website</a>