Technical Design of Vessel for 2025 Maritime RoboBoat Competition

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***Abstract*— The "Bayou Bot" RoboBoat was designed and programmed by the Bayou Bot Krewe for the 2025 International RoboBoat Competition. This miniature boat operates autonomously and via remote control. These functional statuses are achieved using a uniquely designed computer control system comprised of Arduino code and module devices. The challenges encountered in this competition address real-world maritime obstacles. The design includes a catamaran style body with four electronic propellers, configured for holonomic motion, beneath the dual hulls. The Bayou Bot includes an enclosure which conceals the control system in a waterproof casing. The control system utilizes Wi-Fi to provide GPS data to the users on shore while the boat navigates and detects obstacles.**

I. Introduction

For the 2025 RoboBoat Competition, the Bayou Bot Krewe designed an autonomous surface vehicle (ASV) to navigate obstacles presented through various challenges. This is the first year the competition has been taken on by the team, so time management and realistic expectations have been the most crucial points in making headway. The Roboboat Competition challenges teams from around the world to design and build independent and unique ASVs to perform tasks and obstacle courses. For the autonomy challenge of the vessel, the boat must complete six mandatory tasks that include: Navigation Channel, Follow the Path, Docking, Speed Challenge, Object and Water Delivery, and Return to Home. Of the many assigned tasks, the Bayou Bot Krewe chose to focus primarily on the navigation channel and migration mapping objectives. The task of navigating a channel requires the ASV to demonstrate basic controlling and sensing capabilities on the water to move throughout a course. The second task involves mapping migration patterns whereby the ASV must maneuver through a complex path with obstacles.

II. Design Strategy

A. System Layout

The Bayou Bot body design includes a catamaran style hull. The ASV’s propulsion system consists of four thrusters. All thrusters are mounted on the keel of the hulls near the bow and stern at an angle approximately 135 degrees to the centerline of the hulls. The ASV is pictured in Figure 1.

The controls system was placed in a waterproof enclosure to prevent environmental damage to any electronic systems. The controls system is comprised of an Arduino Nano. Commands from an operator are provided using the onshore remote control. The remote controller allows the operator the ability to toggle between remote and autonomous navigation modes. The implementation of multiple microcontrollers

Figure 1. Bayou Bot ASV for 2025 RoboBoat competition

Figure 2. Foam core for hulls.

was so independent tasks could be delegated within the control structure to ensure redundancy and manual control in the event of a failure of the autonomous control system. An onshore command station, connected to the ASV via Wi-Fi, enables data visualization as well as the ability to change control parameters without needing to interface directly with the ASV.

B. *System design*

The framework of the ASV is based around a pair of foam filled glass fiber hulls, shown in Figure 2, connected to form a pontoon. This design allows for lightweight, yet buoyant hulls which maintain a positive buoyancy even if the fiberglass shell is damaged. The ASV is equipped with four Blue Robotics T-200 thrusters, strategically mounted at an angle of approximately 135 degrees relative to the hull centerline. With the trusters positioned on the keel of each pontoon near the bow and stern, this configuration provides holonomic motion, allowing the ASV precise and efficient maneuverability. The ASV's thrusters enable longitudinal, lateral, and rotational motion by dynamically adjusting their rotational direction and speed, providing precise and versatile maneuverability, as shown in Figure 3.

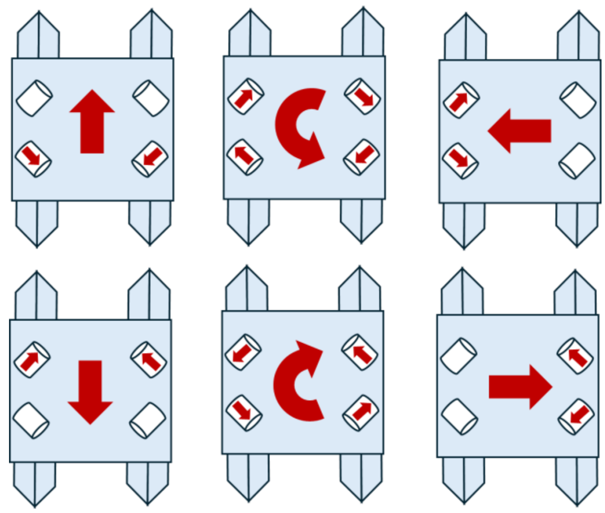

Figure 3. Thruster motion map of ASV.

Each thruster is driven by a flooded 3-phase brushless motor which is powered and controlled by an ESC contained within the waterproof enclosure. The ESC receives a PWM signal supplied by the Arduino from either the manual control system or the autonomous system to provide power and direction to each thruster.

C. *Competition Approach*

There are a total of six tasks that an ASV can perform at the competition: 1) Navigation Channel, 2) Follow the Path, 3) Docking, 4) Speed Challenge, 5) Object and Water Delivery, and 6) Return to Home. The focus of the Bayou Bot is on tasks 1 and 2, due to the current capabilities of the ASV as well as time to implement.

1) *Navigation Channel*

The Navigation Channel tests the ability of the

ASV to pass through gates marked by red and green buoys. Currently, the ASV uses the on-board GPS unit to collect a GPS waypoint at the end of the channel from a remote-controlled survey pass. The ASV will be instructed to go to the GPS point from its starting position at the beginning of the channel. Using GPS waypoints collected beforehand, the ASV will move in five-foot increments. As the ASV travels through the course, it will adjust its course based on the boats bearing to the next waypoint.

The team's overlying goal is to change the programming strategy to be vision-based. Switching to vision-based would lead to the GPS waypoint navigation system being replaced with cameras on the ASV that detect buoy color and make navigation decisions based on the colored buoys present.

2) *Follow the Path*

Follow the Path tests the ASV's ability to maintain navigation through red and green buoys without contacting channel markers. While navigating the channel, the ASV will avoid obstacles represented by yellow buoys along with stationary vessels intermittently placed throughout the channel. The ASV will record the number of obstacles it encounters along the way and transmit this information to a shore-based control center. After completing all tasks, the ASV will navigate to its launch point while avoiding all obstacles and buoys in its path.

The task will be accomplished similarly to Task 1, Navigation Channel, but with more functionality requirements. The ASV will collect GPS waypoints through an initial remote-controlled survey pass then be instructed to follow the waypoints, like breadcrumbs. While navigating, the ASV must move through the course and gates without colliding with any obstacles. This will be done using a series of ultrasonic sensors placed strategically around the control box on the ASV. The sensors will be programmed to read distance, and once a certain distance is read by either of the sensors the boat will adjust navigation to avoid the obstacle. The boat will be programmed to back up a certain distance from the sensor that read the certain distance and then continue down the course. The ultrasonic sensors will detect and count the number of obstacle buoys, log the information, and report to the onshore command center.

Similarly to Task 1, the team aims to replace GPS waypoint navigation with vision-based navigation where colored buoys will be detected, and command decisions will be dictated by the colored buoys present in the image.

3) *Tasks not being completed*

The Bayou Bot will not attempt tasks 3, 4, 5, and 6. These tasks require more advanced control and functionality than the ASV is currently equipped with. The team aims to accomplish these tasks for the 2026 competition.

III. System Testing

Testing of the Bayou Bot appears in many different forms. Dry run testing, as shown in Figure 4, and water trials, as pictured in Figure 5, have been utilized to prepare for the

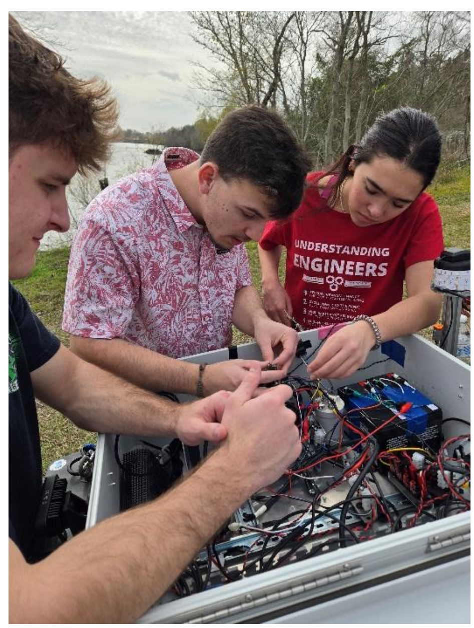

Figure 4. On shore electrical testing.

Figure 5. Testing of remote control at Airport Lake in Lafayette, LA.

competition. Dry testing was done to test all the electric components before starting water trials. In this stage relays, motors, and Wi-Fi range were tested. These were all done to ensure that when water trials were started, there was no serious worry about components failing. Dry testing was very beneficial to diagnose problems the boat was experiencing and able to be corrected before competition and water testing. Once dry testing was done, water trials began. The boat was brought to a local lake where it was first run via remote control to test the range of the remote if autonomous mode failed during the trial. This was done to ensure that if the boat did fail during competition, it could be switched to remote mode to get it back to the starting area. Once the range was tested the boat was able to be coded to run in autonomous mode to be able to prepare for the competition. The lake was set up in accordance with what the boat would see during its run in the competition so it could be tested to the environment it would have to perform in.

These methods of testing are what helped bring the Bayou Bot to life and get it ready for the competition. Without testing there would have been no way to know what would happen when it will run during the competition. The tedious testing not only helped understand what the boat could do, but how all the coding and components worked together to achieve the various tasks. The knowledge gained from the various testing has helped tremendously when it comes trouble shooting during the competition.

IV. COMPETITION PREPARATION

Similar to the testing strategy measures were taken to ensure success of the Bayou Bot at competition. Weekly meetings were conducted to make sure all tasks were adequately completed. These tasks consisted of making sure everything with the Bayou Bot was able to perform how it is expected to. The main thing that was needed was to get the wiring in the control box figured out before any actual testing could be done. Without knowing which wires were which the code couldn't be perfected to be able to run the individual components. Thats why teams were made to address these problems and help move the project along faster and be able to start testing.

Communication and documentation were big parts of preparing for success at competition. Communication was needed to make sure that work wasn't overlapping and everything being worked on was its own task and deadline that could be relayed to the other team members. Documentation has been another point of focus for competition, so that when troubles arise it can be noted, and a solution can be written to help fix the issue quicker. Without previous years documentation the Bayou Bot would have taken longer to get ready for competition and would have not been able to get as much testing done.

V. CONCLUSIONS

The Bayou Bot is an autonomous surface vehicle, with a catamaran style hull. The device is driven by four keel mounted thrusters, directed by an Arduino Nano. The Bayou Bot Krewe placed an emphasis on the first two tasks, Navigation Channel and Follow the path, due to time constraints. Navigation Channel requires the ASV to exhibit sensing and control capabilities. Follow the Path requires that the ASV involves mapping migration patterns whereby the ASV must maneuver through a complex path with obstacles. These tasks are core to the competition and thus require the most mastery. In future iterations of the Bayou Bot, teams should place more emphasis on other parts of the competition's, beings that this team's focus was developing proficiency in these areas.

VI. Acknowledgements

The Bayou Bot Krewe extends its heartfelt thanks to Mr. Donald E. Mosing for his generous donation, which made this project possible. 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 financial support, resources, and technical advice. Our appreciation goes to the Marine Survival Training Center and the Ragin Cajun Waterski Team for graciously allowing us to use their lake for testing. We would like to recognize the guidance of our faculty advisors, Mr. John Carroll and Ms. Yasmeen Qudsi, as well as Dr. Joshua E. Vaughan who advised the teams prior to 2024. Finally, we are grateful to RoboNation for providing us with the opportunity to compete in the RoboBoat competition.

References

[1] RoboBoat Staff, Jan. 2025, “Team Handbook,” https://robonation.gitbook.io/roboboat-resources