TEAM PHANTOM 2.3.0

Embry-Riddle Aeronautical University 2023

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Abstract

This report discusses the goals and strategies of the ERAU RobotBoat team for the upcoming 2023 RoboBoat competition, in addition to discussing the personnel and resources that have supported the RAER organization. It acknowledges the club's assisting faculty members, sponsors, and other supporting organizations, as well as additional resources and documentation that have led to the success of the RoboBoat team. The report then discusses overall competition goals and strategies, followed by a more detailed description of strategies that will be used to overcome the assigned tasks that will be at the upcoming competition, including design concepts and programming ideas. After discussing these goals and strategies, the report describes the testing plan that is in place for ensuring the success and safety of the upgraded ASV components. This report concludes with an appendix that describes the ASV's components, how the components were acquired, and where more information can be found about them.

Acknowledgements

The ERAU RoboBoat team would like to graciously acknowledge the time, effort, and resources provided by the many students, faculty members, clubs, and sponsors that help make this team successful. In particular, we would like to thank Dr. Coyle and Dr. Currier of the ERAU Engineering Faculty for sharing their time, knowledge, and advice with RoboBoat. We would also like to thank the rest of the RAER Autonomous Systems team for sharing their resources, working space, and advice with us, and for inspiring us with their own robotics projects. Finally, we would like to thank and acknowledge the whole of Embry-Riddle Aeronautical University for their constant support for organizations like our own. With their contributions through the budget-pack and their willingness to allow RAER to use campus facilities and equipment, we have been able to run a fun and successful robotics organization.

Technical Content

I. Competition Goals

For this year's competition, our goal is to attempt most every task in the competition. With such a small team that has limited experience, if we are able to navigate the ASV to each task and try to succeed at each, that would be a great success. We are planning to have the ASV equipped with tools and mechanisms to complete each task, while still remaining within the bounds for weight and size of the craft. We have multiple sub-teams of students each working on designs for different tasks. This way, we are able to "divide and conquer" instead of the whole team working on one task at a time. However, we still make a conscious effort to discuss each sub-teams' work and ideas at our weekly meetings so that everyone on the team is aware of the updates and changes that are being made to the ASV. As we approach the date of the competition, our team understands that due to the complexity of some of the tasks, we may need to prioritize some tasks over others. Optimistically, we would like to complete each task with an ideal mechanism or program, but it is important to understand that we may run out of time to complete these "ideal" concepts, so we are prepared to simplify our designs in order to have the ASV ready for competition on time.

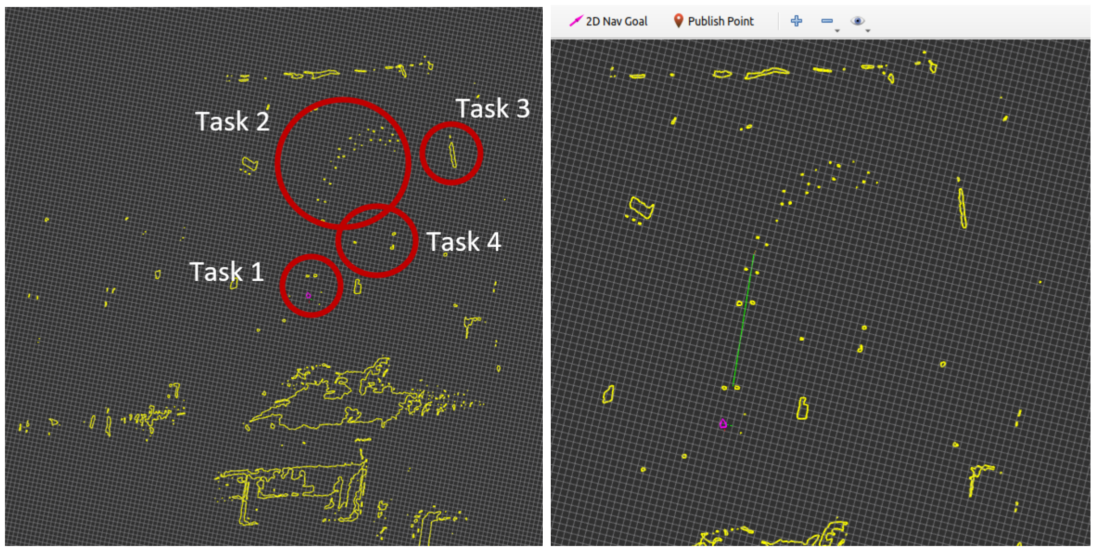
II. Design Strategy

The *Phantom 2.3.0* is ERAU's most recent competition-ready ASV and it will be returning to competition in 2023, so all of our basic maneuvering, propulsion, and vision systems are already in place. However, this year's competition includes many unique tasks that will require some substantial changes to the vehicle.

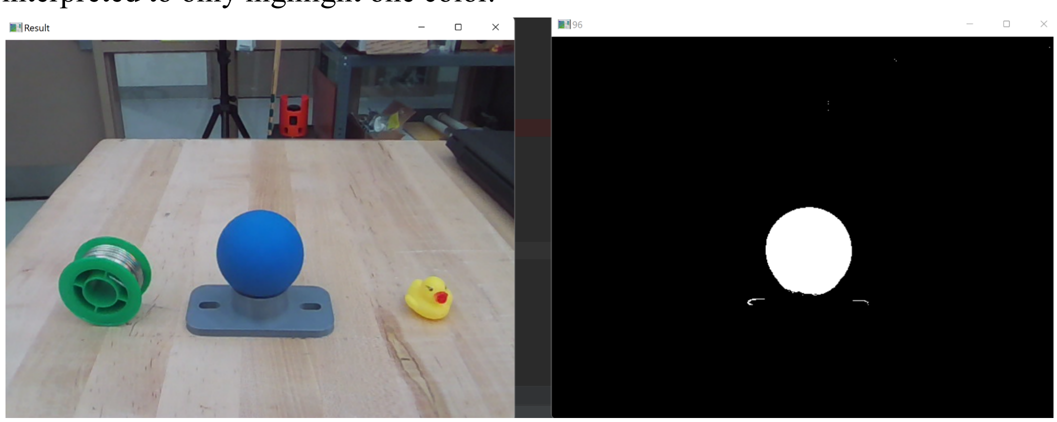
Task 1-4:

The software programs for tasks 1 through 4 use lidar, gps, and camera data to detect obstacles and navigate around them. To successfully navigate through these tasks, the team used ROS, C++ and Python as the programming languages. The filtered lidar data is plotted using Rviz (the 3D visualization tool for ROS). From the figure below the team can see on the monitor screen all of the obstacles present detected by the velodyne sensor. The data shown in that figure was recorded using the rosbag tool during the 2022 Roboboat Competition.

The path is created with Rviz's 2D Nav Goal tool by clicking anywhere on the map to create a point. The path is represented by a green straight line as shown in the second figure. The amount of points used to complete the run vary for each test. To achieve a curved path, more points are needed. Once the boat is switched to autonomous control, motor commands are sent to control the thrusters and follow the gps points. Different motor values will allow the boat to successfully complete path following. The software doesn’t take into account the change in water current and wind. The boat will drift and can potentially touch the buoys. However, the next gps point and camera data will redirect the boat to get back to the intended path.

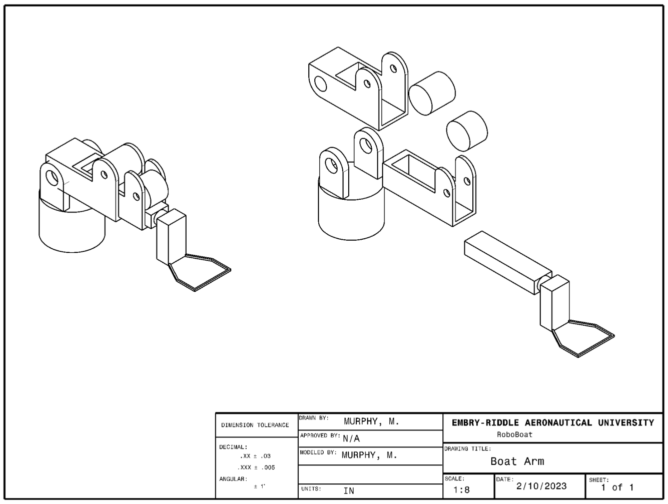


The use of a Camera will improve our navigation and tracking skills during the competition. Using a mask and hsv value the boat can locate the different color buoys and coordinate its position between them. With this color tracking the boat is able to count the buoys as necessary in the second task and identify the available docks in the third. As you can see in the figure below there is the actual image being fed and the mask image being interpreted to only highlight one color.



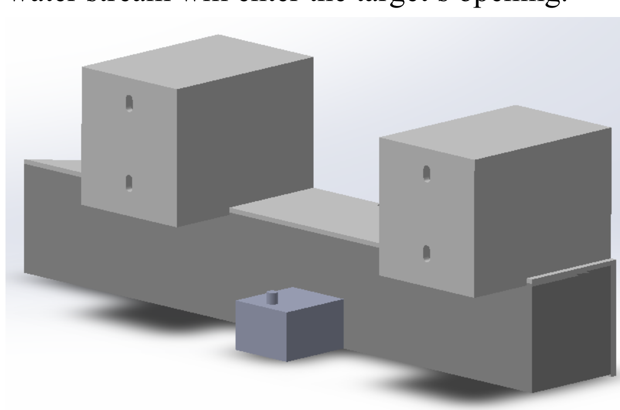
Task 5 (Ocean Cleanup):

This task requires balls to be picked up within a 5-foot enclosure, Phantom 2.3.0 will complete this task using a mechanical arm with a net attached to the end. A few ideas were drafted, but it was decided that the one below was the most feasible. When retracted, the arm is approximately two feet, when extended, it will reach almost three feet over the side of Phantom 2.3.0. The length is not finalized, so we plan on redesigning the arm to retract further back. To compensate for vertical distance, and to keep the rotating servo on the end dry, the net on the end of the arm dips down. Although, a servo would still be required at the base to tilt the arm up and down.



Task 7 (Ponce de Leon):

To complete task 7, we need to fill a container with enough water to lift a ball beyond a set line. Phantom 2.3.0 will complete this task by attaching a water pump to either the port or starboard pontoon. The pump will be fully submerged, so that it can intake the water, and will have a tube shooting the water through the forward part of the boat. The team will create a circuit to turn the pump on with enough time to fill this container to the required amount. Phantom 2.3.0 will detect how far the target is, and position itself so the water stream will enter the target's opening.



CAD drawing of the pump attached to the inside of the starboard side

III. Testing Strategy

In order to prepare for the upcoming competition we have developed strategies in order to test the new components being added. We are modeling more of our component layouts and testing them in different areas of the boat for the maximum efficiency in competition. Focus on using data collected from last year's competition is key for our success this March. Creating one for one creations of the tasks and getting the equipment we expect to see at competition is paramount to the team. Moreso we expect to do more testing on the software side in order to hone in on the location, path planning, and object visuals/detection of the boat. With these combined strategies we can produce a more successful and improved boat design than before.

Appendices

I. Appendix A: Components List

Component	Vendor	Model/Type	Specs	Cost	Custom /
ASV Hull	Developed	N/A	Sealed and laser-cut plywood		Custom
Amas	Developed	N/A	Sealed and laser-cut plywood, insulation foam		Custom
Fiberglass Exterior	Fiberglass Plus	Marine Gel Coat	http://www.fiberglassplusinc.com/gelcoats.html		
Waterproof Connectors	N/A	N/A	Hand made with silicone sealant		Custom
Propulsion	Blue Robotics	T200 Thruster	https://bluerobotics.com/store/thrusters/t100-t200-thrusters/t200-thruster/	200$	
Power Systems	Thunder-Power	6S LiPO and 4S LiPO	6600mAh, 4400mAh	233.99$ and 140.99$	
Motor Controls	RC Electric	30A ESC	https://www.amazon.com/RC-Brushless-Electric-Controller-bullet/	36$	
CPU	Amazon	Intel NUC 8	https://www.amazon.com/Intel-NUC-Mainstream-Kit-NUC8i5BEH/dp/B07GX59NY8/ref=asc_df_B07GX59NY8/?tag=hyprod-20&linkCode=df0&hvadid=309743296044&hvpos=&hvnetw=g&hvrand=11119711738487598755&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9011497&hvtargid=pla-623465415047&psc=1	431$	

Teleoperation	Spektrum	Spektrum DX6i	https://www.spektrumrc.com/product/dx6i-6-channel-full-range-w-o-servos-md2/SPM6600.html	Discontinued	
LIDAR	Velodyne	Puck	https://velodynelidar.com/products/puck/	Donated	
IMU and GPS	VectorNav	VN-300 Dual Antenna GNSS/INS	https://www.vectornav.com/products/detail/vn-300?gclid=CjwKCAiArY2fBhB9EiwAWqHK6u6_QLX5EMrgtM5a29lNJoT_1nEvBZLs7zSyu0wI_gDZNJPstKBfbhoCylgQAvD_BwE	4,000$	
Camera(s)	Teledyne Flir	Blackfly USB3 w/ 1920x1200 fixed focus lens	https://www.flir.com/products/blackfly-usb3?model=BFLY-U3-23S6C-C	595$	
Algorithms			ROS(Robot Operating System) C++ and Python		
Vision			OpenCV		
Localization and Mapping			GPS/IMU Vectornav		
Autonomy					
Open-source Software			C++ and Python		