# Ragin' Cajuns RoboBoat 2021


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***Abstract*— This report discusses the design choices and improvements made to the University of Louisiana at Lafayette's first entry in to RoboNation's RoboBoat Competition that includes an Unmanned Aerial Vehicle (UAV). This UAV is to be a mobile sensor for the ASV using its onboard sensors, which include a Real–time Kinematic (RTK) GPS system System, a Raspberry Pi Camera Module, and an OAK–D machine vision sensor. The Ragin' Cajuns RoboBoat is a catamaran-style autonomous surface vessel (ASV) equipped with four thrusters in an "X"–configuration, enabling holonomic motion. The contributions to the ASV from the 2021 Ragin' Cajuns RoboBoat team include finishing the upgrades to the new electronics enclosure that were hindered due to COVID–19, adding a RTK–GPS system, and upgrading the previous vision sensors to OAK–D machine vision sensors. The framework that controls the communication between various computers and the implementation of control and mapping algorithms is the Robot Operating System (ROS).**


## I. Introduction

The 2021 RoboBoat competition requires teams to build an Autonomous Surface Vessel (ASV) capable of performing various tasks that require several subsystems to function together. The ASV shown in Figure 1 is equipped with two planar LiDARs for depth perception, two OAK–D stereo cameras for machine vision feedback, and a RTK–GPS and an IMU for localization. The vessel is equipped with four thrusters mounted in an "X"–configuration, enabling holonomic motion. This vessel is equipped with two Lithium polymer (LiPo), one 10A hour battery for its thrusters and another 5.2A hour battery for the electronics. This two battery configuration allows the E-Stops to kill power to thrusters without removing power to the electronics.

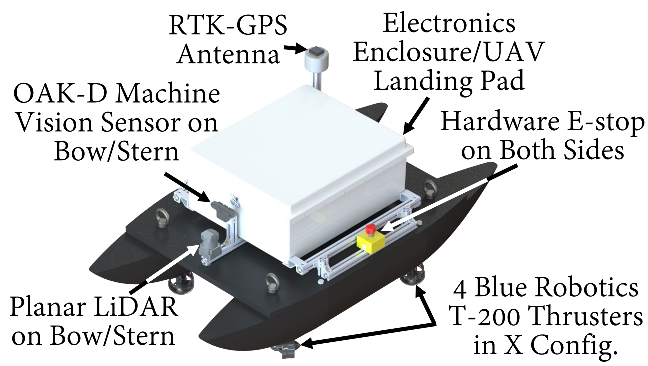


Fig. 1: 2021 Ragin' Cajuns ASV CAD Model

Ah is the unit

We use 10Ah for both

For the 2021 RoboBoat competition, the team added an unmanned aerial vehicle (UAV) to be used as a mobile sensor to collect data to assist the ASV in mapping, navigation, and localization. The UAV, shown in Figure 2, is equipped with RTK–GPS, standard GPS, and an IMU for localization, OAK–D stereo camera for mapping, object recognition, and obstacle avoidance, and a a downward–facing Raspberry Pi Camera Module V2 (Pi Cam) for additional image data collection. It is also equipped with a downward–facing single point LiDAR–Lite for altitude augmentation, an RC receiver for manual flight, and flotation gear


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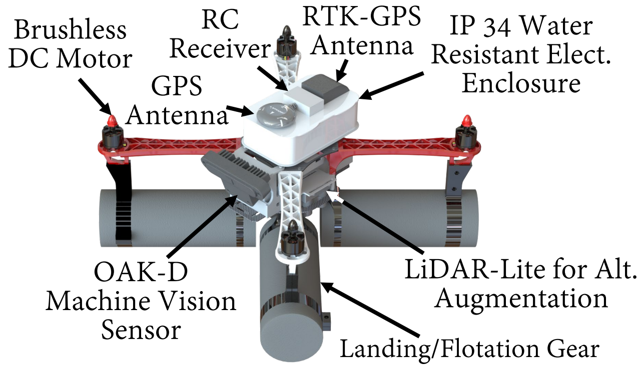


Fig. 2: 2021 Ragin' Cajuns UAV CAD Model

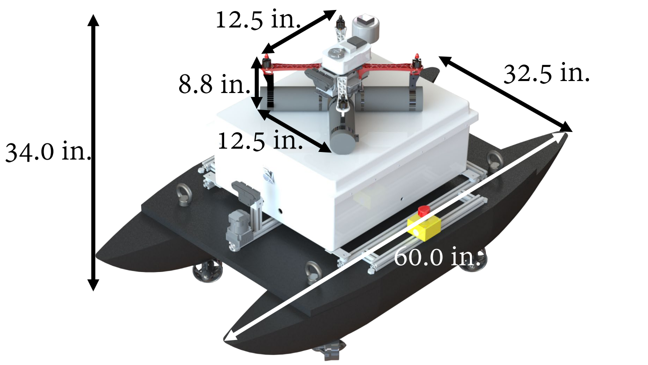


Fig. 3: 2021 Ragin' Cajuns Autonomous System

to ensure buoyancy. This UAV ~~is~~ powered by one 9.2A hour, 100C discharge rate d LiPo battery ~~to allow for the system to consume the needed power when operating in a course~~. The size of the battery was ~~also~~ chosen to give an approximate 17 min flight time in standard conditions. The total 2021 Ragin' Cajuns autonomous system is shown in Figure 3 with its key dimensions highlighted.

Is 17 min enough?
What is "standard conditions"?

In the next section, the competition strategy for the 2021 competition is discussed. The design creativity of the ASV and the new UAV are discussed in Section III. In Section IV, the experimental results that were gathered are presented. Finally, Section V is the conclusion. A list of components is also presented in the Appendix.

## II. Competition Strategy

The past competitions have shown that the Ragin' Cajuns ASV is an adaptable and capable vessel for RoboBoat's challenges. However, there was room for improvements including utilizing a UAV in the competition, upgrading localization and sensing components, and improving the control architecture of the system. This year, integrating a UAV and upgrading the localization of the system were selected as the main foci. The following sections will discuss the strategic approach for the UAV integration and how the system will operate in the competition.

### A. *UAV Integration*

Through an analysis of the past competitions, it was determined that the team could potentially obtain an approximate 1,200 additional points by adding a UAV that takes off of and lands on the ASV, as well as competes in the UAV specific task. The addition of this UAV to the current ASV requires tight integration of software and mechanical design. To facilitate the integration of the UAV's and ASV's sensing, mapping, perception, and controls, the Robot Operating System (ROS) is used. To ensure the designed UAV could be integrated to the ASV, computer–aided design (CAD) models of the UAV and ASV were created and updated throughout the process. While this integration increased the complexity of the system, the ASV can operate independently of the UAV, allowing for each run to continue even if the UAV fails.

For the 2021 competition, the UAV will be deployed after the mandatory Navigation Channel is completed and move to the next section of the course. This allows the UAV to be one task ahead of the ASV to collect data and place waypoints for the ASV to navigate towards with increased accuracy due to the RTK–GPS system's correction data. The UAV is fitted with an OAK–D machine vision stereo camera to differentiate between the various buoys that will be encountered during the competition and to avoid possible obstacles and a downward–facing Pi Cam to find ArUco markers on top of the ASV's electronics enclosure when landing and object recognition.

### B. *System Software*

A mix of custom and standard ROS packages are used for the control, perception, and mapping.