RoboBoat 2020

FAMU-FSU
College of Engineering

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Department of Mechanical Engineering

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Background

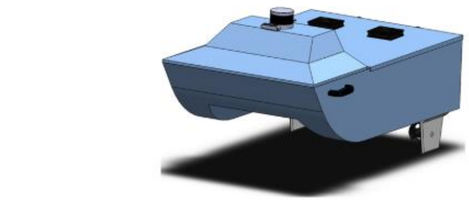
RoboBoat is an annual international competition organized by RoboNation. Scholastic teams compete by designing and building autonomous vessels that are tasked with certain challenges such as a speed test and obstacle avoidance course.

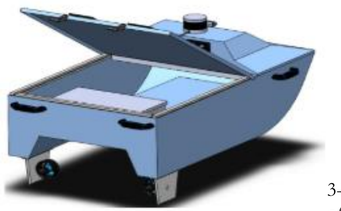
Objectives

- Fabricate a boat hull capable of floating for 30 minutes while transporting 25 lbs
- Boat will have capabilities of navigating an obstacle course autonomously as well as navigating in a straight line

Design

The engineering design process was utilized to design a boat hull that met the needs of the competitors and fit within the rules of the competition. The result is a hybrid monohull-catamaran which incorporates the strengths of both boat types.





3-D CAD drawing of the final design

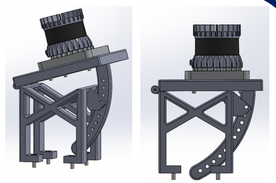
Manufacturing

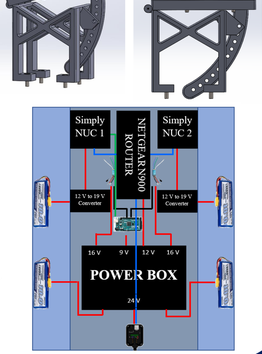
To construct the hull a fiberglass composite was chosen consisting of 6 oz fiberglass cloth, 1.5 oz fiberglass mat and epoxy resin. This material selection then dictated the manufacturing process. Using the dimensions from the CAD model, a foam mold of the hull was created. Four layers of fiberglass cloth were hand laid on the mold then sanded. Finally, a moisture resistant paint was applied to the bottom.

Hardware

Sensor mounts were developed with 3D printing in mind in order to be easily produced in case of failure and also to be cheaply made. These mounts also allow for articulation for angle adjustments for the sensor.

There were many components that were wired and integrated into the test boat. A power box, containing step up and step down voltage converters, was used to power the LiDAR, router, Arduino Mega board, and two ESCs (each were connected via barrel or XT60 connectors). Two 4S LiPo batteries were connected to this power box via XT60 connectors. The ESCs were connected the Arduino to receive signals and thrusters were connected to the ECSs via screw terminals. Two computers were each, separately, connected to a step up voltage converter, powered by a 4S LiPo battery. The LiDAR and two computers were also connected to the router via Ethernet cables.





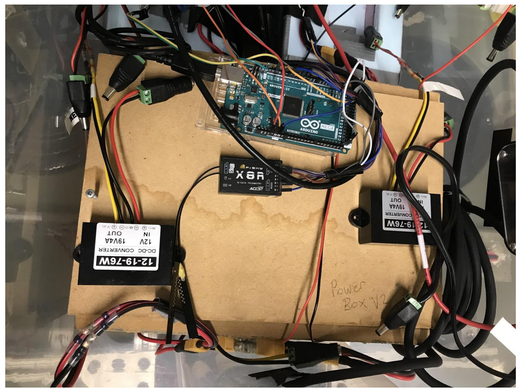
Software

To start, the team created a Proportional Integral Derivative (PID) controller to safely operate and drive the vehicle manually and autonomously. The team then used a microcontroller to implement a motor mixer which employs a differential thrust locomotion method. After we integrated a remote control (RC) into the vehicle and combined it with motor mixing code to drive the vehicle from radio control. For precautionary purposes, we incorporated three safety systems into the vehicle controls

1. Hard wired emergency brake switch
2. Software switch that shuts down thrusters
3. RC failsafe that shuts down thrusters in the event of transmission loss.

To achieve autonomy the sensors and the vehicle were localized within the ROS environment. By incorporating data from a Vectornav IMU and Ouster Lidar, the vehicle was enabled to use waypoint navigation using the ROS navigation stack and move base. For future steps, the team would want to complete the navigation challenge for the competition and fully calibrate physical magnetometer on the IMU.

Testing



Future Work

The next step is to install all sensors and software from the test boat to the newly manufactured hull.