# Sailbot 2022-2023

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**Advisors:** Kenneth Stafford, William Michalson

**Abstract**

The goal of this project was to further develop WPI's current Sailbot, an autonomous robotic sailboat created to compete in the Sailbot International Robotic Sailing Regatta. In preparation for this competition, we further developed the mechanical, electrical, and software components of the robot to improve navigation, function, and design.

**Project Goals**

1.The boat can autonomously plan a course and navigate to within 10 meters of a given GPS location

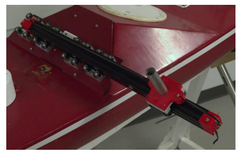
2.The boat can navigate around a course of GPS locations for at least 8 hours

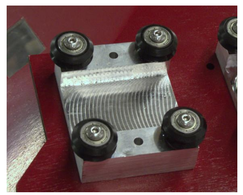
3.The boat can detect and avoid buoys and obstacles within 5 meters in front of it

4.A human operator can remotely control the boat within a range of 500 meters

**New Linear Rail Moveable Ballast System**

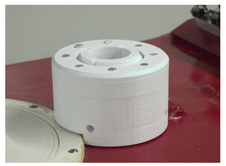
- Controls angle of heel of the boat while sailing
- Optimal heel angle helps to minimize skin drag between the hull and the water
- Accepts standard 1" barbell plates as ballast
- Ballast weight can be adjusted depending on wind conditions

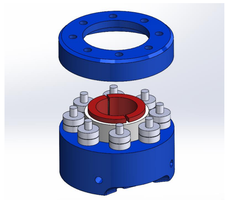




**Redesigned Mast Holder**

- Uses a plastic bushing to prevent direct contact of the metal bearings on the carbon fiber mast
- Prevents damage to the carbon fiber mast
- Allows the mast to spin freely in its socket
- 3D printed enclosure helps protect bearings from being exposed to water





**Acknowledgements**

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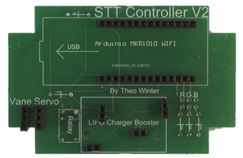
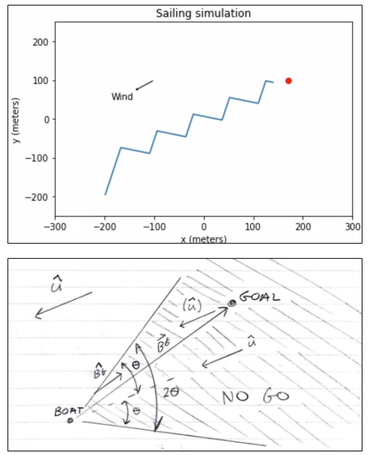
- Previous Sailbot MQP teams for their work and documentation of past research

**Wingsail Printed Circuit Board Improvements**




- The Wingsail's battery can now be charged without having to open the electronics box
- The wiring is much more secure (the old protoboard jumper wires would frequently become unplugged)
- Code can be uploaded to the Arduino while the battery is charging
- Enclosure semi-permanent limiting direct interactions with its internal components increasing longevity

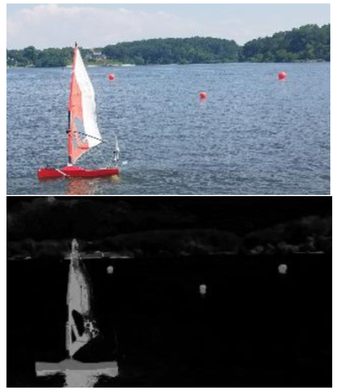




**Navigation Algorithm**

- Target position is generated using GPS coordinates
- Heading is determined using dot product math of the current wind vector and the direct track to the goal
- Returns the optimal heading to the goal and controls the rudder to steer the boat in the correct direction.
- Sends either max lift or drag commands to the trim tab depending on current apparent wind direction.
- It allows for more end user accessibility so it can be reused at many different competition sites.

$$D_{pswitch} = \cos(\theta - sin^{-1}(\frac{C_{temax}}{|\vec{BG}|}))$$



**Computer Vision**

- Done through centroid detection
  - Images converted to HSV
  - Pixels given values of 0 or 1 depending on color (hue)
- React to nearby markers
- Detect and avoid collisions
  - Change course if necessary