Boat Team

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Ty, Josh, Deon, Justin, Saarth, and Daisy

UCSD COSMOS 2022 - Cluster 13: Hacking 4 Oceans
Autonomous Boat Team

By: Justin Leong, Deon Petrizzo, Josh Tian, Tyler Synder, Daisy Zeng, Saarth Gaonkar

Abstract

In this project, we built an autonomous boat that can travel according to waypoints and GPS coordinates to record ocean precise data. The main objectives were maneuverability, being able to pull a buoy, making parts water resistant and being able to switch between auto and manual operation modes. We then used the app Mission Planner to be able to chart a course and set up controls. An autonomous boat allows for greater precision in GPS coordinates.

Figure 1: Boat 1 on Mirmar Lake

Project purpose

We were tasked with converting a Traxxas high-speed RC Boat into an autonomous boat, which could follow GPS waypoints.

Software

Our boat was controlled by a flight controller which ran on Ardupilot, an open source firmware often used for drones. To update the firmware of the flight controllers, we used QGroundControl. After all the hardware was up to date, we used Mission Planner, a ground control system, to interact with the FC, control and configure the hardware of the boat, and plot GPS waypoints, which the boat would automatically follow. In the final GPS guided route we created, we implemented timed stops at each waypoint to give ample time to take measurements of the lake.

Figure 2: Justin (software guy) working on the boat

Materials

Hardware:

- Traxxas Boat
  - ESC
    - Motor
    - Pixhawk flight controller
      - GPS
      - Computer radio
      - RC radio
      - Servo

Software:

- Mission Planner
- GitHub
- Onshape
- QGroundControl

Mission Planner

ArduPilot's software Mission Planner became a huge part of our project. We did everything from set up RC controls to mapping the route we flew. The software is not the most user friendly so we had to do a lot of research to get it running properly. This was where we spent the majority of our time bug fixing and finding other problems with both software and hardware.

Figure 3: Mission Planner

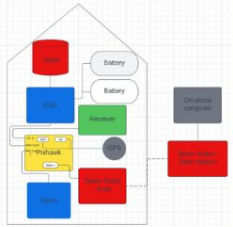


Figure 4: Wiring diagram for components

Methodology

- Download new firmware for flight controller
- Replace battery connectors
- Replace radio for the RC
- Solder connectors (Not needed once we switched to Pixhawk flight controller)
- Set the radio for the computer to its own channel
- Plug in GPS
- Do the compass calibration
- Plug in radio (test connection on ground control)
- Go into parameters and set FRAME_CLASS to 2 for boat
- Plug servo to main port 2 and throttle into main port 3
- Test using the motor test and reverse turning or throttle if needed.
- Set up map
- If done right should be good to go

Hardware

We started with a stock boat from Traxxas to modify. We first had the Lux H7 for our flight controller but ended up replacing it with the Pixhawk due to time complications. We then used a NEO-M8N BDS Compass Module GPS and a pair of SiK radios to track coordinates and communicate between the boat and the computer. To calibrate the radios we installed the latest radio firmware through mission planner and created the same settings between the 2 radios. For the GPS, since it was placed outside the boat for better connection, we waterproofed it.

Figure 5: Rudder iterations

Figure 6: 3D printed extended servo arm

Figure 7: Final 3D printed rudder

Figure 7: 3D printed water resistant enclosure

Challenges

Throughout the process of making the boat we encountered both hardware and software challenges. In our first pool test, we thought that a larger propeller was needed to provide enough power for the boat to pull the buoy. However, after 3D-printing two, three, and four blade propellers around twice the size, we realized that the PLA plastic broke at higher throttle. In addition, some of our teammates accidentally burnt two flight controllers due to incorrect wiring. On the software side, Mission Planner was difficult to use at times because of its complicated UI. Most of our tasks involved a lot of research and hacking due to the unfamiliarity of this new cluster.

Conclusion

By the end of the project, we were able to successfully build an autonomous boat capable of following GPS coordinates and pulling a buoy to collect oceanographic data. The boat followed the waypoints effectively, but future work could focus on building a stronger radio connection since the antenna may have been at or under water level. None of the electronics were damaged due to water-resistant enclosures, and later modifications improved wire management.

Figure 8: Collecting data at the lake

Acknowledgements

Professor Jack Silberman Ph.D.
Lecturer: Ivan Ferrier
Teacher Fellow: J. Michael Tritchler
Teacher Assistants: Melody Gill, Devanshi Jain, Dallas Dominguez
An additional thank you to our counselors, teachers, and parents who made it possible for us to be here!

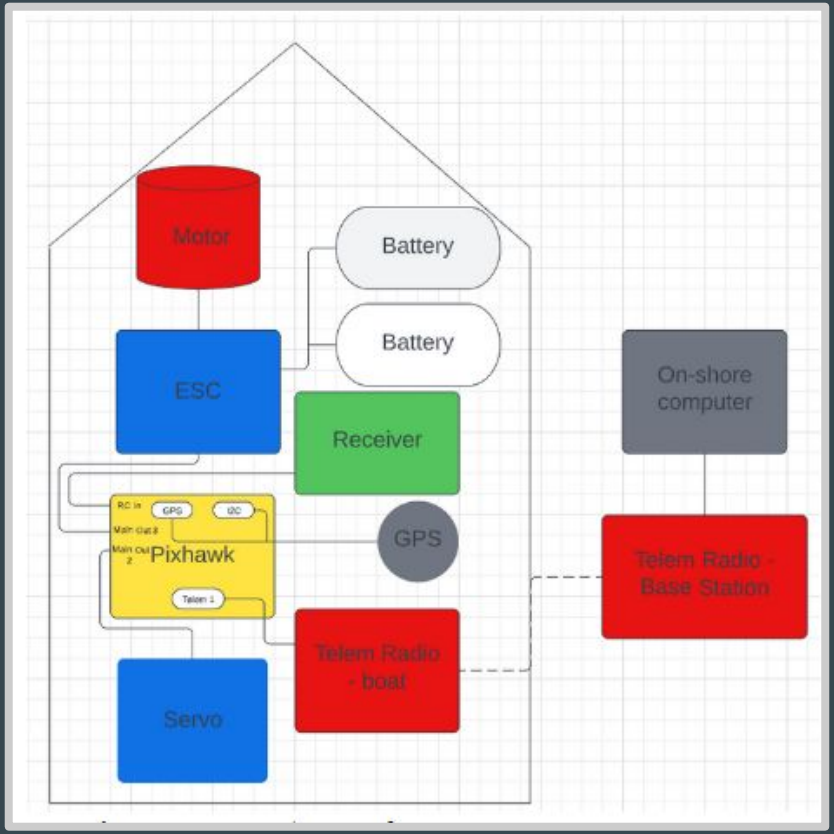
Goals

- RC Boat => Autonomous Boat
- Maneuverability
- Pulling a load
- Water resistance
- Fail safe mechanism

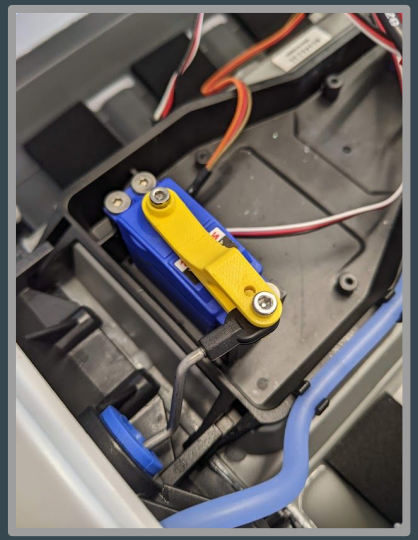
Software

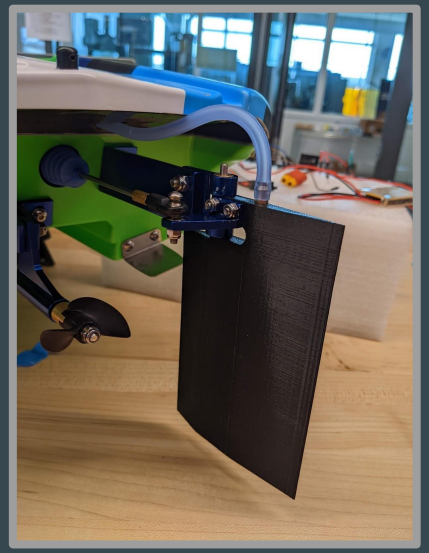
- **Ardupilot** (firmware on flight controller)
- **Mission Planner** (ground control software)
  - Configure hardware
  - Plot and run GPS routes
  - Add specific waypoint events

Hardware: Electronics



Hardware: Custom 3D printed parts





Improved steering system

Water resistant enclosures for the electronics

Hardware: Iterations


WARNING

Challenges

Hardware:

- Wiring GPS
- Frying boards

Software:

- Mission Planner => complicated UI
- Pairing Sik radios

Conclusion

Success:

- Boat followed GPS waypoints
- No water damage
- Agile steering

Future Improvements:

- Stronger radio connection

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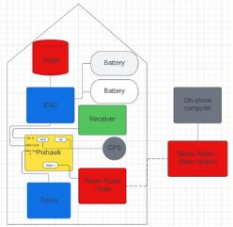

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