Boaty McBoatFace Meets RoboBoat 2016

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***Abstract*— This document describes the Daytona Beach Homeschooler's entry to the RoboBoat competition. Topics in this document include: the new vehicle name, lessons learned from RoboBoat 2015, the overall strategy to accomplish the competition tasks, and the team's outreach efforts. New hardware this year includes: a tethered submersible, new thrusters, and hydrophones.**

Keywords*— *Autonomous, RoboBoat, Sonar, PixHawk, APM Rover

I. Introduction

Our first entry to the RoboBoat competition was in 2015. We entered the competition to learn more about GPS navigation. Due to the number of challenges in the RoboBoat competition, it was difficult to achieve all of the tasks. We chose to focus on navigation and vision processing. We did not have hydrophones so we did not attempt to locate the pinger. Despite many mistakes and malfunctions, our performance was better than expected. We finished in 4th place overall.

A. The New Vehicle Name

In 2016 the British Navy had an online poll to name their new Artic research vessel. Over 100,000 people voted for the name Boaty McBoatface [1], but the British Navy chose the Sir David Attenborough despite the support for Boaty McBoatFace. To respect the will of the people we're naming our boat, Boaty McBoatFace

B. Challenges Encountered in RoboBoat 2015

The very first problems in the competition involved buoyancy issues. First, the boat nearly sank due to incorrect assembly. The next problem that the team encountered was that the competition was held in a freshwater lake while the boat was tested in a saltwater pool. Needless to say, the boat lost buoyancy in the fresh water and a slab of green foam was required to be added to the bottom of the boat to maintain buoyancy.

The next problems to occur were problems caused by magnetic interference. As soon as the boat started its run, the boat would turn hard to the right. This turned out to be because the compass was getting confused, Mission Planner continually reported "compass variance" and the team was unable to fix the error. The variance in the compass not only caused the beginnings of the run to start out askew, it also caused the boat to crab through-out the course, never going completely straight. This is shown in figure 1. The yellow line is the ideal track, the purple line is the actual track of the vehicle, the green line is the direction the boat is heading, and the red line is the direction the compass is reading.

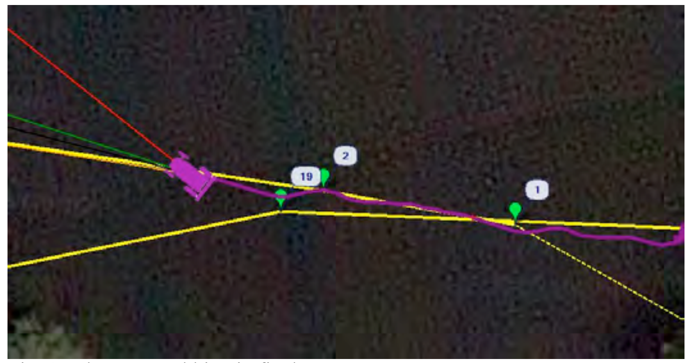

Fig. 1 Telemetry crabbing in final run.

The boat has an internal and external compass and the boat was programmed to use the external compass, but because of a bug in Mission Planner [2], the team was unknowingly using the internal compass. The internal compass was near the motors and could have been affected by the currents caused by the motor. Figure 2 shows the compass variance error as well as showing that the system thinks the boat is descending rather than going across the surface of the water.

The last significant problem was due to the limited accuracy of waypoints provided by the competition. During

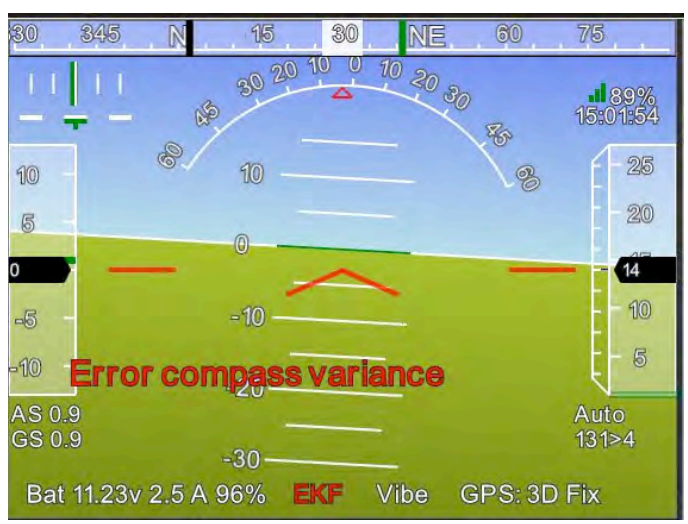

Fig. 2 Compass variance error

the docking task, the boat runs the risk of driving to unreachable waypoints and getting stuck since the control system lacked the ability to time out on way-points. A secondary problem that was realized during the competition was that the docks are near the edges of the lake, meaning that errors in position could cause algae to get caught in the motors.

During the final run of the competition most things went well. For unknown reasons, the boat wasn't affected by a magnetic anomaly at the beginning of the run. The course had been completely changed for the finals to prove that the teams were navigating and not running off of pre-programmed maps. The boat successfully navigated the entire course.

The only problem encountered during the final run was a networking problem. Early on Sunday morning, the day of the finals run, there was a hardware failure on the router and the team was forced to replace it. When the team finally received a replacement router it was tested to verify that it worked by communicating with the test server. Unfortunately, in the haste to be ready for the finals, the programmers forgot to switch the server they were sending messages to and sent everything to the test server rather than the competition server. This simple mistake cost the team numerous points for not being able to report their results or status during the run.

II. Improvements for 2016

The boat was redesigned to handle a heavier payload. The PVC pipes have been replaced with foam pontoons. A custom aluminum frame and a custom enclosure box were fabricated using facilities at one of our sponsors, Germfree.

Fig. 3Nick machining the frame

Figures 3 and 4 show the construction process.

Fig. 4 Nick welding the frame

This year's competition requires deployment and recovery of a submarine to navigate and take pictures of an underwater target. The team was able to leverage our experience with RoboSub [3] and SeaPerch [3] to create a suitable submarine. The sub is designed with the same thrusters used in the SeaPerch competition

Last year's boat was underpowered; this year we are using Blue Robotics thrusters which provide over 5 times the power of our old thrusters.

Sparton Inc. donated a pair of hydrophones to our team. We don't have a high-speed analog to digital converter, so we lack the ability to sample the hydrophone signals at full rate. We will be sampling the hydrophone signals using the audio card on a laptop PC. This will make the measured pinger frequencies hard to understand, but they will be consistent.

Abigail has been working on vision processing algorithms in LabVIEW for Embry-Riddle's RobotX [5] platform. The algorithms she developed have been converted to openCV. Figure 5 shows the detection of a red circle in a cluttered enviroment. There are different colors for the RobotX and RoboBoat competitions.

Fig. 5 Red circle target detection

II. Boaty McBoatFace Hardware

Figure 6 shows the boat in the water. The GPS antenna, and kill switch are highlighted.

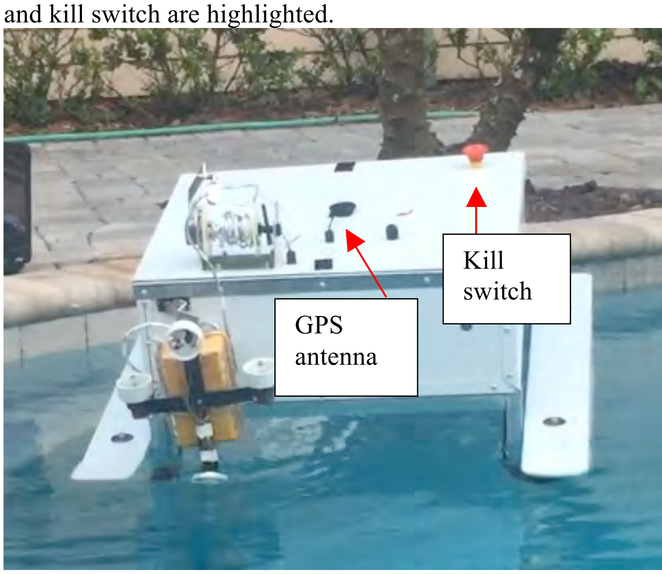

Figure 6 GPS antenna and kill switch

Figure 7 shows the submarine and submarine deployment system.

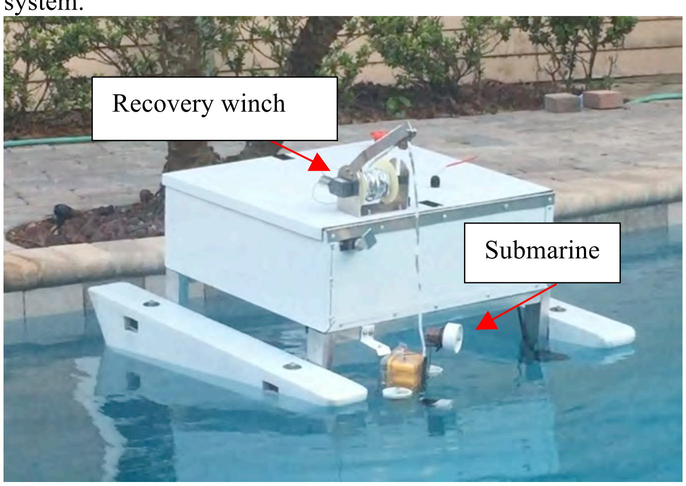

Figure 7 Submarine and submarine deployment system

III. Outreach

The Daytona Beach Homeschoolers mentored two group of middle-school level homeschool students in the design, construction, and fabrication of SeaPerch submarines. Abby and Nick each led a team and provided the supplies, equipment, and mentoring necessary to build successful SeaPerch vehicles.

Some photos of the students building the SeaPerches are shown below. The groups meet for 90 minutes a week in a nearby park.

Fig. 8 SeaPerch assembly begins.

Fig. 9 Nick teaching soldering

Fig. 10 Abby teaching electrical assembly

After several weeks, the SeaPerches were complete and testing began.

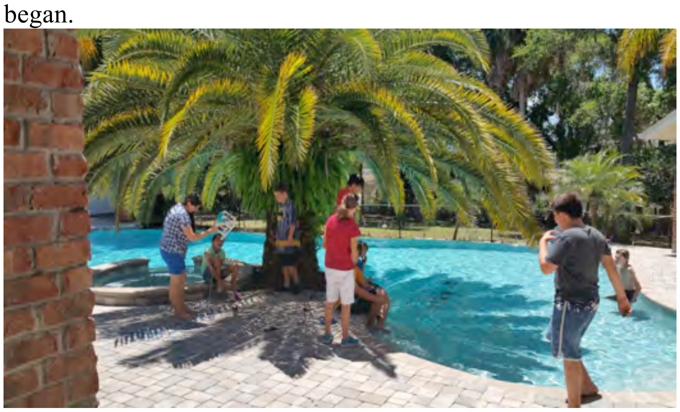

Fig. 11Testing the SeaPerch in the pool

A total of 8 students stuck with the effort through the entire design, fabrication and testing process. The students that did not participate are looking forward to joining in next year.

Fig. 12 The homeschool group mentored by Nick and Abby.

IV. Conclusion

This year the team will have the hardware, software, and experience necessary to attempt all competition challenges. We enjoyed sharing our enjoyment of STEM with our homeschool group. We hope to leverage our success in 2015 with our improvements in vision processing to successfully execute all of the RoboBoat 2016 challenges.

V. References

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