

Short Range Wave Glider

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Abstract—Being able to study our bodies of water is extremely important to understanding our earth and how climate change is affecting it. Robotic, underwater collection devices are being designed and utilized to help with this endeavor. By taking a robot that is traditionally used in an oceanic setting and modifying it to be suited for research in the Great Lakes, a different form of data collection can begin to take place and further increase our knowledge for that region. The Short Range Wave Glider combines the benefits of several different underwater robots and is designed specifically for Great Lakes research.

I. INTRODUCTION

The Great Lakes hold approximately one-fifth of the world's surface freshwater. They are also the singular home of many animal species, both in the lakes themselves and along their shorelines. [2] This makes them a unique and important ecosystem. However, they are under many different threats, such as pollution, invasive species, and climate change. Pollution can come from runoff, mining operations, and from toxicants that are released into the water. Unfortunately, a minimal amount of water leaves the lakes which causes pollution to build up over time and become a semi-permanent part of the ecosystem. [2] Furthermore, the effects of climate change on the Great Lakes can be devastating. Not only will climate change continue to decrease the quality of the water within them, the changing climate will exacerbate the problem of pollution and invasive species in the lakes. The changing environment within the Great Lakes due to climate change is making the lakes suitable for invasive species. Additionally, the hotter temperatures cause the lakes to recede, causing the wetlands which would normally act to filter pollution from entering the lakes to dry out. [2]

Research must be done throughout the Great Lakes and other large freshwater bodies to understand and counteract the factors that threaten them. By having an autonomous or semi-autonomous system gathering data from around the lake, factors such as, but not limited to, water temperature, air temperature, and water quality could be monitored and recorded. Also, the threat posed by invasive species could be more closely monitored and controlled. On average, a new non-native species is found in the Great Lakes every 28 weeks. [2] By utilizing data gathered at various points throughout them, the populations and movements of these invasive species can be monitored and studied by researchers to control the inflow of non-

native species and their overall impact on the ecosystem. By measuring other aspects of the water quality, such as pH level, conductivity, and oxygen level, the effects of pollution on the lakes could be studied. This information would not only be useful from a research standpoint but could also be used by communities surrounding the lake who may be using the lakes' water for city or agricultural purposes.

Long Range robots, such as the Liquid Robotics Wave Glider, are not necessary for bodies of water like the Great Lakes. The Wave Glider is designed and built to withstand extreme weather and temperatures, as well as be in use for months or even years at a time. Since the freshwater bodies are much smaller and experience much less extreme conditions, using such a robot would be a waste of resources. Unmanned Surface Vehicles themselves are not widely used in the Great Lakes, even for longer range applications, and are unheard of for shorter range applications which are ideal to help supplement currently ongoing research.

II. MATERIALS AND METHODS

The Short Range Wave Glider is comprised of three different areas, electrical, mechanical, and computer science. Each of these areas had to be developed to work seamlessly with each other to create a working robot.

A. Electrical

The Short Range Wave Glider requires several different electrical components to work, the first of which is powering the robot. It is powered using several sets of lithium polymer batteries. These batteries create a network of varying voltages throughout the wave glider that power a variety of sensors, microprocessors, and computers. The second component is comprised of the environmental sensors. These sensors were chosen and placed throughout the robot to be able to detect conditions underwater. This includes detecting water temperatures and aquatic bioacoustics. These sensors will work together to give an indication of the water conditions around the Great Lakes and the correlating animal life. Lastly, a communication and navigation system was developed. This system was created to allow for the wave glider to complete obstacle avoidance, and determine its position, speed and heading all throughout the Lakes. Furthermore, the communication system takes the data that is being collected by the environmental sensors and transfers it to modems that would be available at

different points throughout the lakes, making it so that data could be available to process and study before the Short Range Wave Glider returned from its mission.

B. Mechanical

Mechanically speaking, the Short Range Wave Glider consists of three major components: the float, the submersible, and the tether that will connect the two. The float, which will ride on the surface of the water, is used to house the batteries, a microprocessor, and the computer which will be responsible for reading and storing all the environmental data collected. It is covered to protect the inner components from any water and has two hatches to allow the operator to access the components from maintenance. Wires connecting the sensors in the submersible to the computer and the batteries in the sub will pass through the tether. Finally, the sub will contain the environmental sensors on the Glider, as well as the rudder and thruster system which will be used to steer the entire robot.

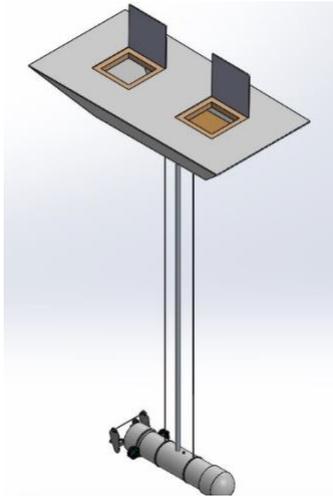


Figure 1: Model of finished mechanical design showing float with both hatches open, the connecting tether, and the submersible.

C. Computer Science

Each of the electronic subsystems and sensors had to be coded and integrated. The various sensors are managed by a microcontroller development board which pipes data into a microprocessor development board where the data is managed within a ROS framework. The ROS framework is used to manage all other subsystems. In the ROS framework, the data from the sensors is interpreted and recorded. The interpreted data was used to determine position, heading, and incoming obstacles. All of this information was compared to the predetermined geo-bounded area of operations to determine if alterations to the course were necessary and instructions were sent to modulate the steering mechanisms as needed.

III. RESULTS AND DISCUSSION

The prototype of the Short Range Wave Glider was designed and built to house all the components needed as well as be resistant to the environment found in the Great Lakes. Between the float and the submersible, the wave glider holds the combination of environmental sensors that will be used to create a picture of the health of the Great Lakes regions. Each of the systems was tested individually to prove that it could work together to accomplish the tasks set forth for it. The mechanical aspects of the prototypes were shown to be waterproof for extended periods of time. The environmental sensors gave indication that they could pick up accurate readings and store, send, and process this information. Although, due to the circumstances, the prototype was not able to be tested throughoutly as a comprehensive unit. However, due to drawings in CAD, wiring diagrams, and testing of basic code, it was shown that the Short Range Wave Glider would have been a success underwater data collection device.

IV. CONCLUSIONS

Overall, the prototype of the Short Range Wave Glider was built as a first iteration of an efficient and creative underwater data collection robot that was intended specifically for the Great Lakes. While the manufacturing phase was limited due to unforeseen circumstances, each system of the robot had a proof of concept created and tested. With the success of these tests, it could be concluded that the Short Range Wave Glider would have been proficient in its tasks as a data collection device. Its sturdy and relatively small chassis is an asset to being used within the Great Lakes Regions. Furthermore, its combination of environmental sensors helps to create a portrayal of the water conditions around the lakes.

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REFERENCES

- [1] "Long-Range Autonomous Underwater Vehicle Tethys." *MBARI*, 28 Aug. 2019, <https://www.mbari.org/at-sea/vehicles/autonomous-underwater-vehicles/long-range-auv-tethys/>.
- [2] "The Great Lakes." *National Wildlife Federation*, <https://www.nwf.org/Educational-Resources/Wildlife-Guide/Wild-Places/Great-Lakes>.

