Autonomous Surface Vehicle with DAQ

COSMOS Cluster 7 - R4US - Robots for Undersea Science

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Purpose (Why)

The purpose of this project was to develop an autonomous vehicle that was able to survey the health of bodies of water through collecting real time data. Collecting this data would allow us to promote environmental awareness, restoration, and protection.

Goals (What)

Our goal is to create an autonomous surface vehicle (ASV) that is equipped with a temperature, water pH, and oxidation reduction potential otherwise known as redox potential sensors. The ASV frequently transmits recorded data via a telemetry radio to a base station where the data is stored in a database.

Abstract

ASVs (Autonomous Surface Vehicles) use in modern applications has made significant strides across various fields. Here, we will delve into the following key areas: environmental and climate data collection, location mapping, and robotics research. ASVs play a vital role in monitoring and collecting data on environmental and climate conditions. We were able to collect a diverse set of real time data from the surrounding environment of the lake including pH, various temperatures, and redox potential readings; all of which can be utilized to create a method for predicting each, in cases where not all sensors are available. Additionally, the use of ASVs in location mapping has revolutionized mankind's ability to explore and map underwater terrains. Through GPS tracking and plotting, we were able to locate the robot and trace where each data point was collected, which allows us to map out fluctuations and outliers within the lake and enables future analysis. As the predicted soon to be leader in robotics research, ASVs provide a platform for testing and developing new technologies in autonomous navigation, sensor integration, and largely environmental interaction. Through our work with gathering data, we were able to accomplish these tasks, allowing us to get a glimpse at what environmental monitoring technologies could potentially be relevant in the future.

Design (Data)

The software of our project can be divided into two main parts, a data side and autonomous side.

Data Collection

To monitor environmental conditions, we utilized Metro M4 microcontroller, a redox potential sensor, a water temperature sensor, and a water pH sensor, as well as a GPS module and two telemetry radios.

When the vessel was in the water, the sensor values were transmitted along with the GPS data about the location and time of the reading through the telemetry radio on the boat to the telemetry radio on the base station, where the string of numbers was transformed into an organized database which could be used for further analysis, finding patterns, and data visualization.

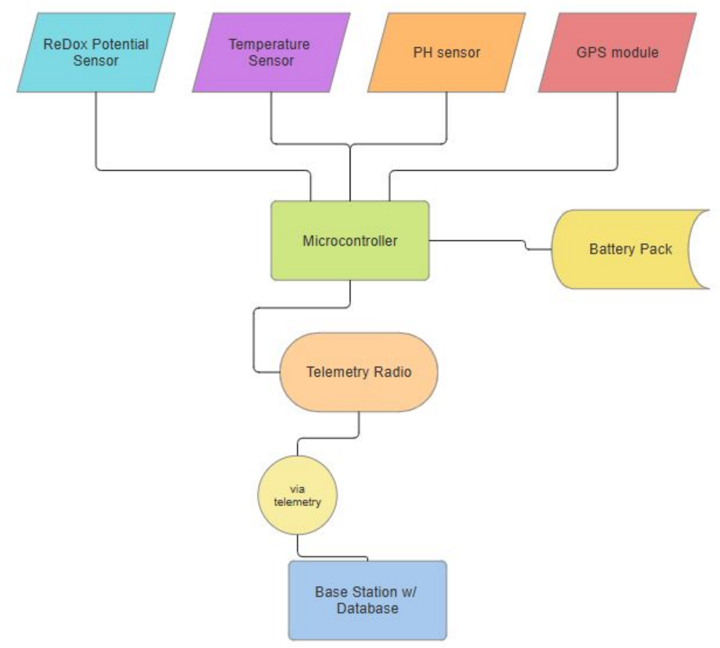

Figure 1: A flowchart of the data software

Autonomous

The autonomous side was set up so that using the on-board flight controller, a radio would send telemetry signals to a base station with positional data and the base station could send out GPS waypoints for the autonomous vessel to move to.

Design (Mechanical)

When presented with this challenge, we were given a list of required parts to fit onto our USV. These being: a flight controller, a Metro-M4, two thrusters, a pH sensor, a temperature sensor, two GPS sensors, and two telemetry radios.

Design (Mechanical) (Continued)

We used a computed aided design tool in order to collaboratively design mounts and custom base plates for all the components.

When designing the ASV, we had planned to fit all the components into two different water proof boxes and attach them via screws to a boogie board. This, however, proved to be a challenge, so we decided to combine the content of the two boxes into one by stacking the mounting plates that we used previously on top of each other. This proved to be our most effective design, even through multiple iterations.

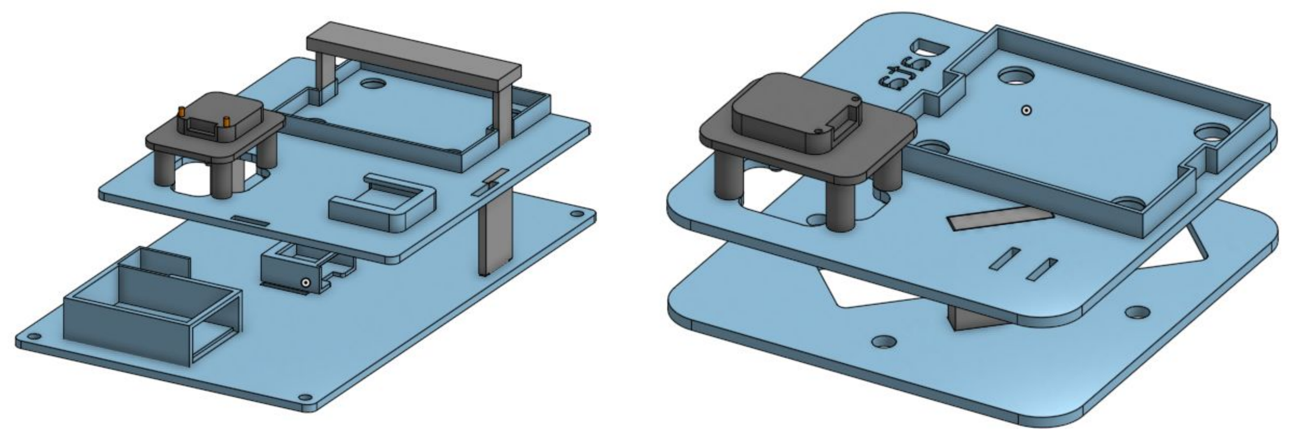

Figure 2: 3D models of the base plates

Challenges and Successes

Successes

Our team successfully designed a robot that collected various data providing meaningful conclusions about the environment, reliably sent the acquired data to a base station, could be manipulated manually, and was able to travel to a set waypoint in autonomous mode.

Challenges/Next Steps

Data wise, we run into issues where the redox potential sensor and the pH sensor interfered with each other's readings. To solve this issue we only recorded data from one sensor at a time. If we were to redo this project, however, we would have used an isolation board to prevent sensors form influencing each other. Another issue we run into was troubleshooting with all the components mounted on the boat. Because of close proximity of all the electronics, it was hard to trace wires or modify anything. To improve this we would have better organized the insides of the box with all the components. Additionally, during testing we run into issues where the telemetry radios would disconnect if the boat was around ten meters away from the base station. We would have used stronger radios to be able to collect data in further areas.

Results & Analysis

All of the groups were able to collect data about the environment at the Miramar Lake in San Diego. After analysis, we noticed some trends:

- Temperature and water pH had a slightly negative correlation - this does not mean that the water was more acidic. This is simply due to the rise in temperature shifting the equilibrium to the left.
- Oxidation reduction potential and temperature had a positive correlation

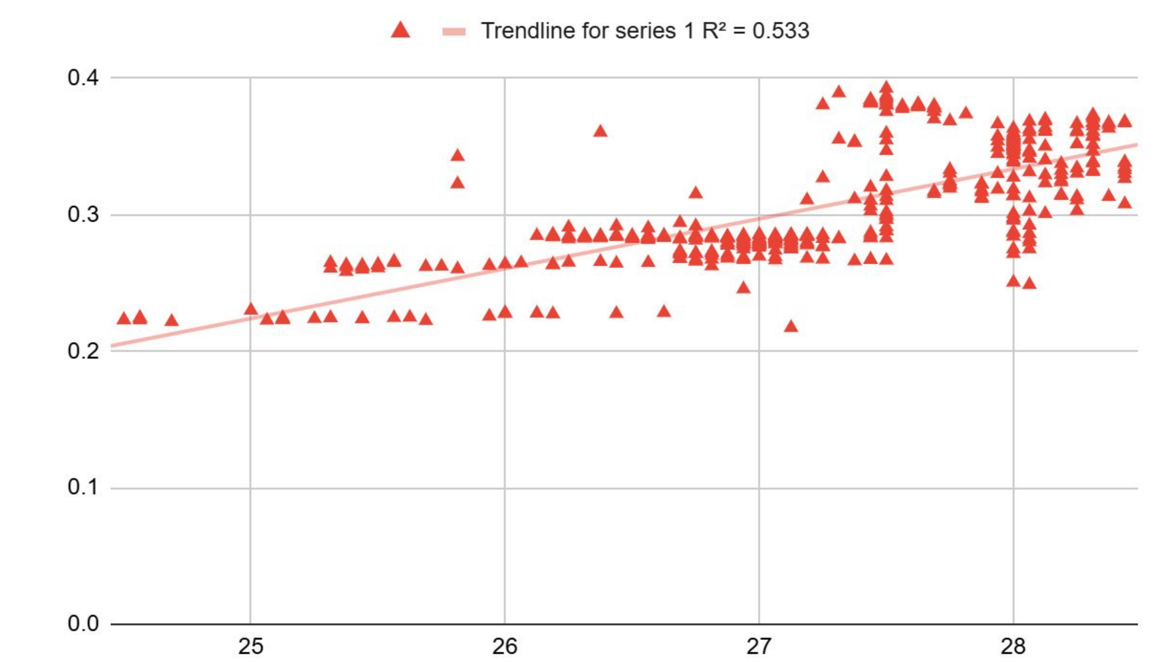

Figure 3: Function of redox potential in terms of temperature

Conclusions

We successfully created an autonomous surface vehicle that can be used to acquire various data about the environment and reliably transmit it to a base station. All of us are grateful to have been part of this project. We were able to learn a lot, as well as have a great time.

References

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Acknowledgments:

Dr. Silberman, Mr. Trichtler, Ethan, Matthew, Steve, counselors, teachers, parents, friends