Autonomous Unmanned Surface Vehicle System for Bathymetric Measurements and Environmental Monitoring

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Problem Statement

To advance in the development of **intelligent systems for ecological sustainability and conservation**, we have developed an **autonomous surface vehicle (USV)** that provides an **economic and sustainable** approach to collecting **environmental and bathymetric measurements** within the Russian River estuary. Our system alleviates the need for local researchers to manually collect data.Advancement in Ocean Engineering technology,including USVs, offer an **inexpensive and efficient** solution for gathering data in wide coverage areas, which can be analyzed to **monitor aquatic ecosystem.**

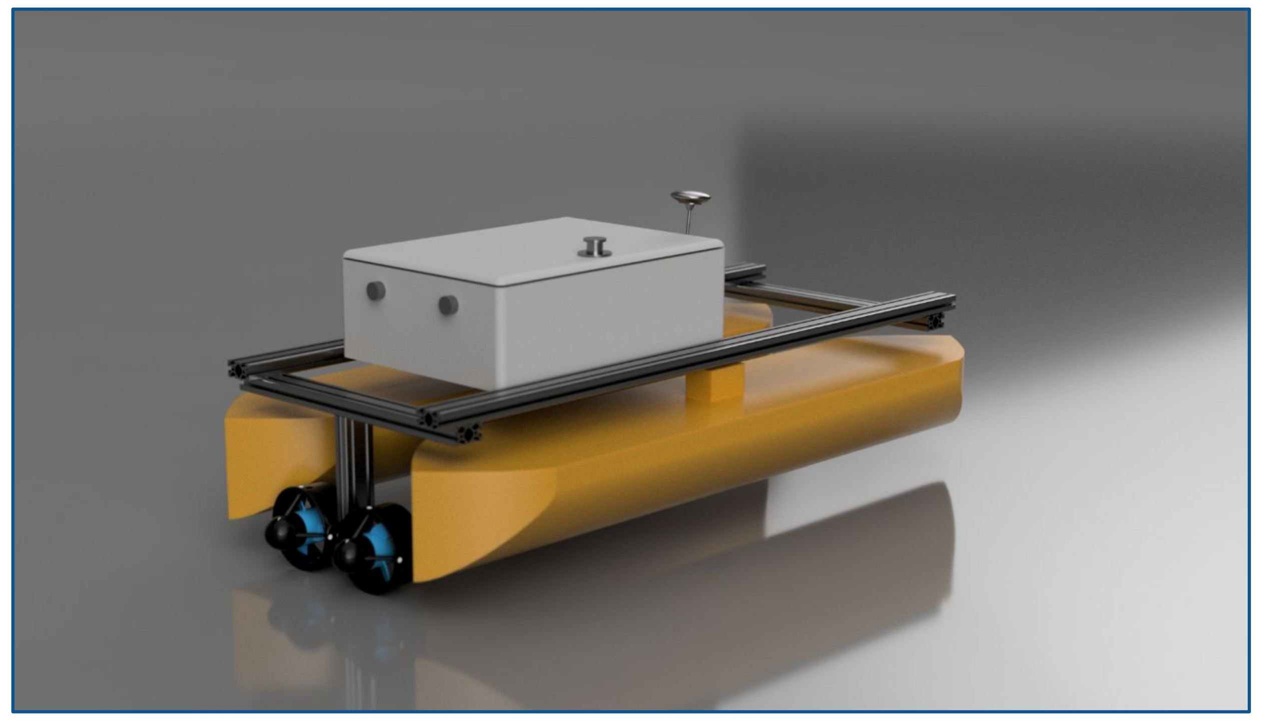


Figure 1: A high-level concept of our USV

Background

The Russian River Estuary is one of many sandbar built **estuaries** along the pacific coast in California. It is a **habitat for spawning of several native anadromous fish** (e.g. Chinook and Coho salmon as well as Steelhead trout). Seasonal breaching of the estuary alters salinity, water depth, and temperature. Researchers rely on manual methods to collect and analyze data.

Objectives

To contribute to the advancement of technology for monitoring global environmental change , our group provides autonomous USV equipped with sensor box that will collect real-time data. All data will be visualized, making coordinate related map, 3D depth plot, Temperature and Salinity Graphs.

System Overview

The USV system is made up of two subsystems: autonomous path planning and sensor box.We will be using Boustrophedon algorithm on flight controller to efficiently collect the most data during its journey. The sensor box on the USV will have our microcontroller and flight controller and sd card where data will be stored.

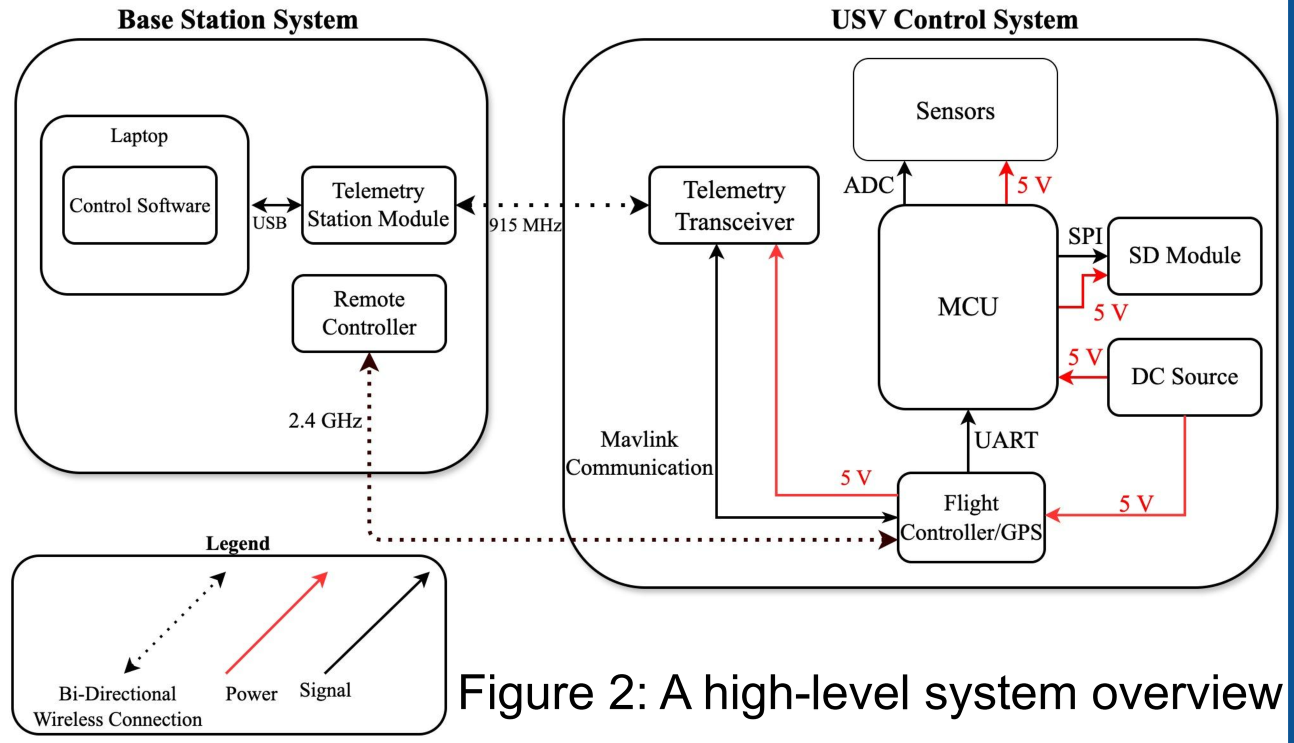
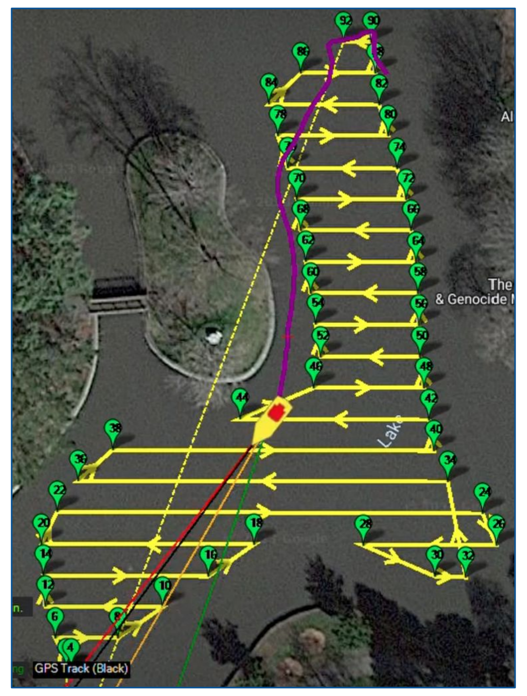
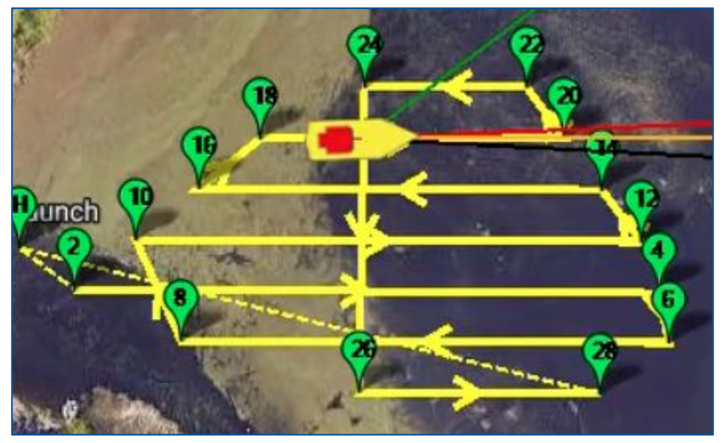


Figure 2: A high-level system overview

Simulated Path Plan Algorithms





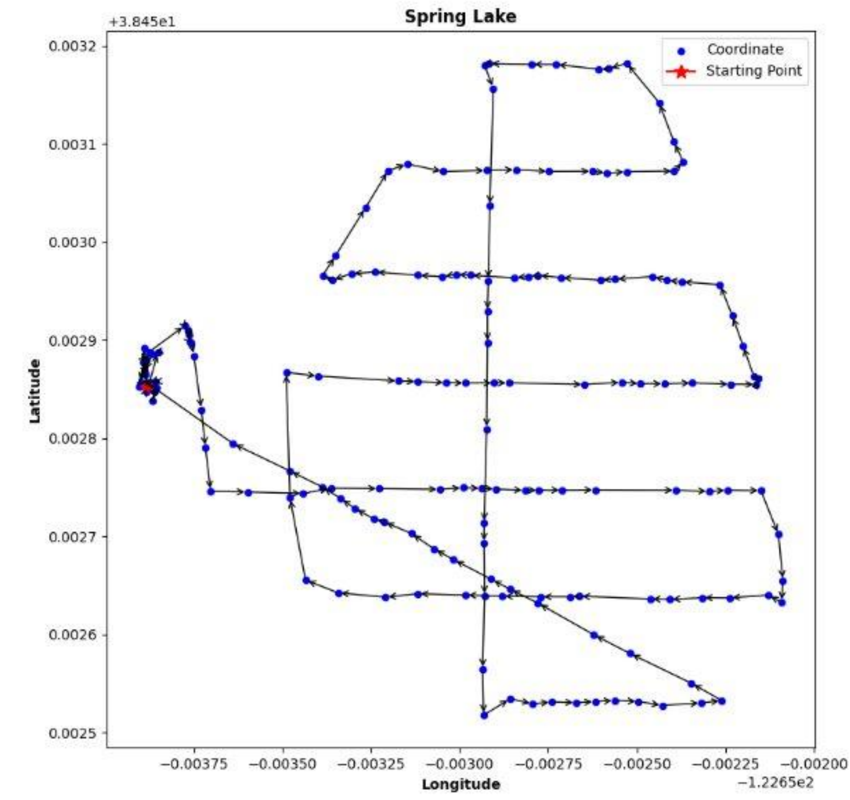
➢ Both images uses Boustrophedon algorithms. Image on left is located in local school pond. Top image is at Spring Lake, Santa Rosa.

Data Logging

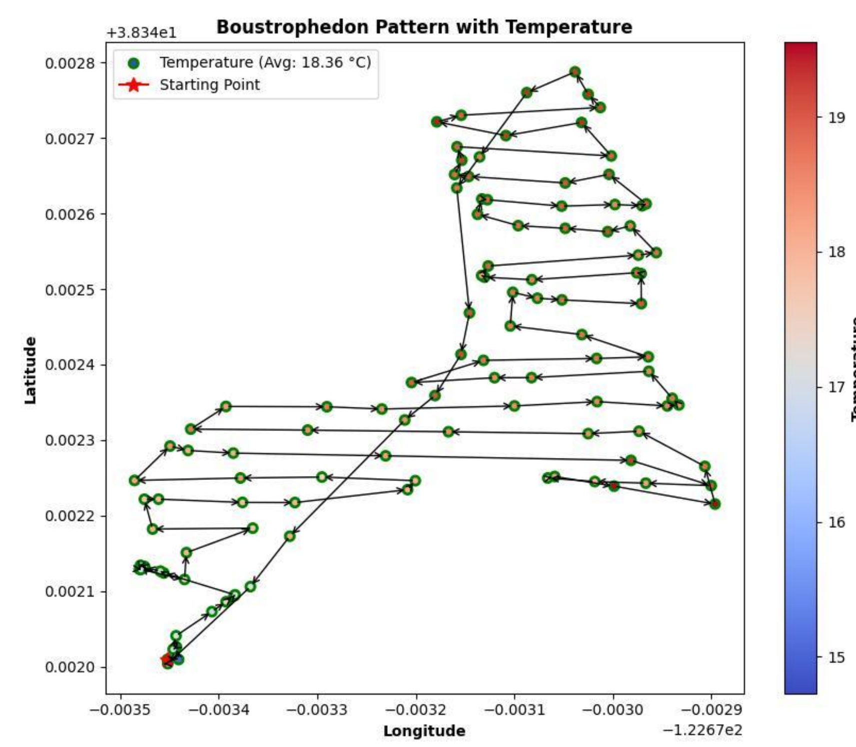
Temperature:	17.93	Salinity:	-1.65	Depth:	9.41	Date:	2/4/2024	Time:	16:55:44	Latitude:	384527946	Longitude:	-1226536400
Temperature:	17.74	Salinity:	-1.51	Depth:	8.5	Date:	2/4/2024	Time:	16:56:26	Latitude:	384528565	Longitude:	-1226538823
Temperature:	17.45	Salinity:	-1.65	Depth:	8.32	Date:	2/4/2024	Time:	16:56:38	Latitude:	384528774	Longitude:	-1226538917
Temperature:	17.55	Salinity:	-1.44	Depth:	7.84	Date:	2/4/2024	Time:	16:56:46	Latitude:	384528554	Longitude:	-1226539012
Temperature:	17.55	Salinity:	-1.58	Depth:	7.84	Date:	2/4/2024	Time:	16:56:57	Latitude:	384528528	Longitude:	-1226539042

Figure 3: Table generated from '.CSV' file, showing last 5 data points out of 160 readings logged.

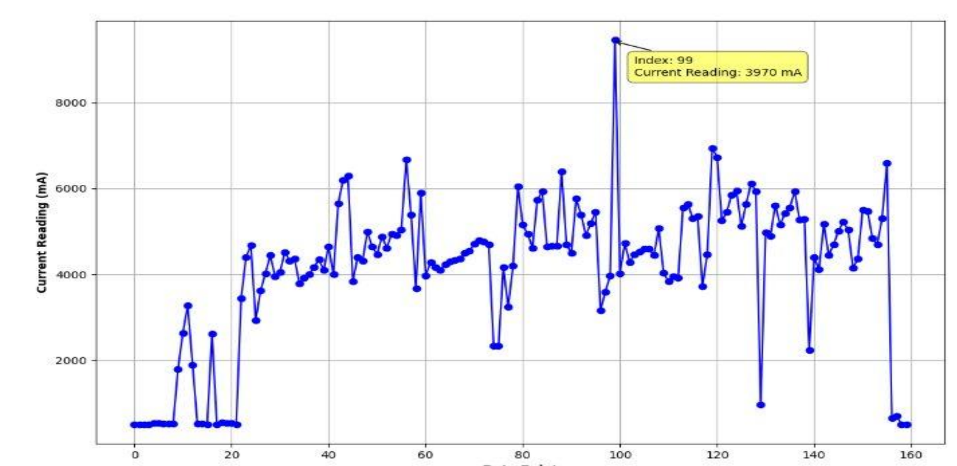
Results Visualization



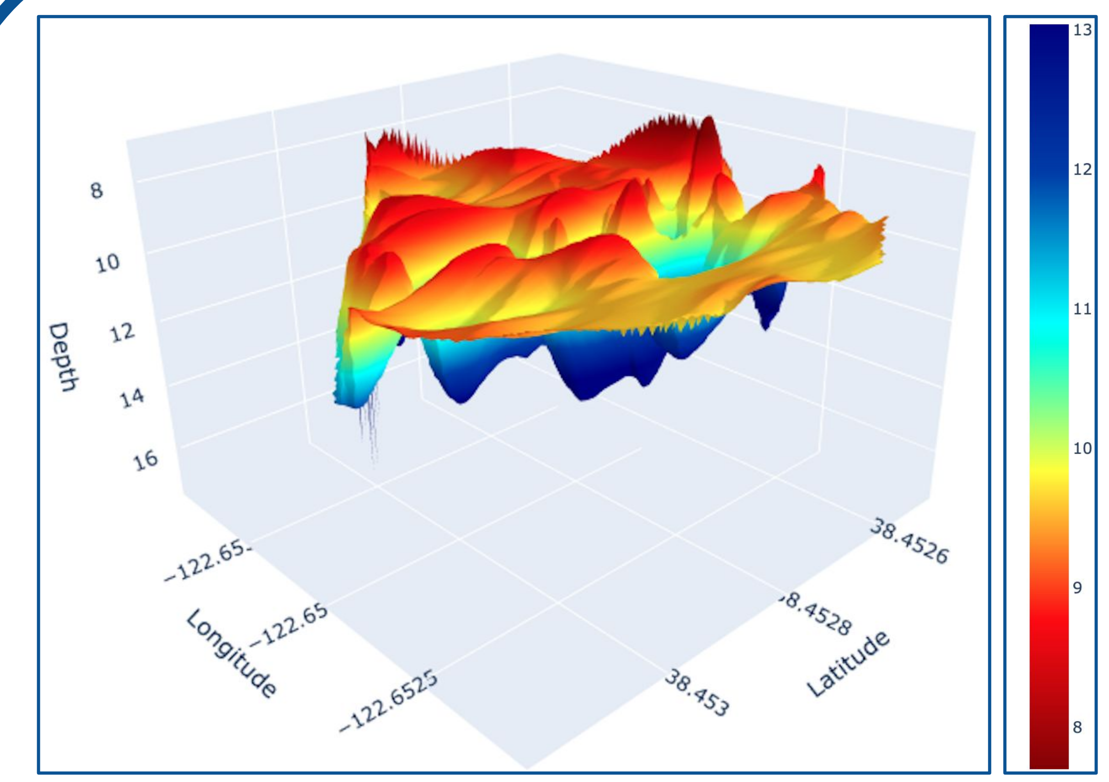
➢ Raw data points plotted using Python. This shows the accuracy and number of data points we get from our system.



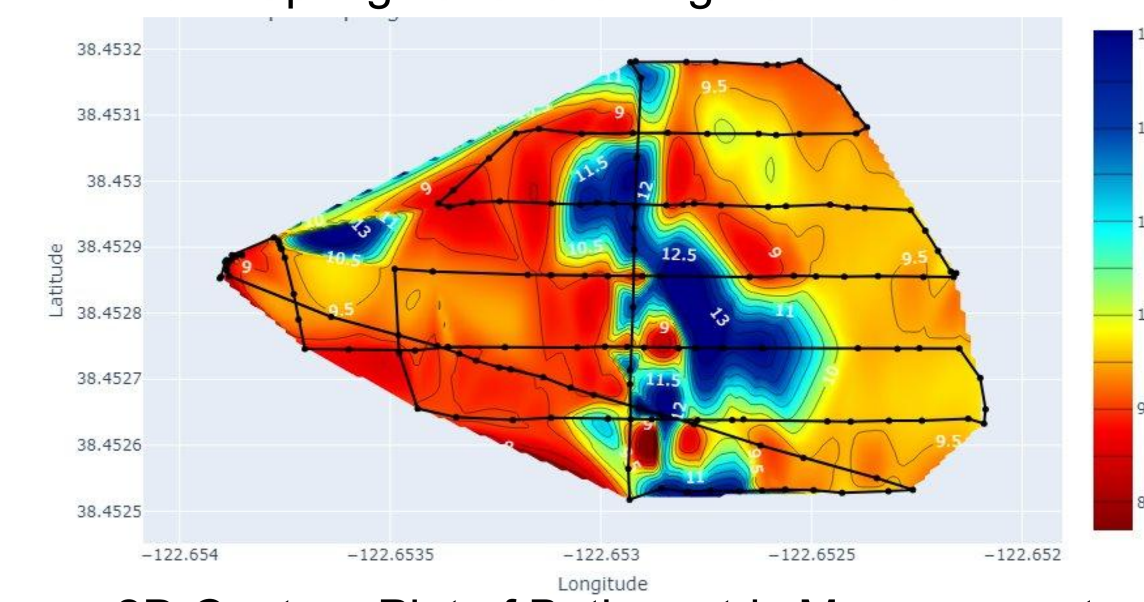
➢ Raw data points plotted using Python. Plot shows direction of path taken. Every coordinate is correlated to temperature reading.



➢ Plot showing data points correlated with current(milliamps) readings. Visualizing where our system is drawing the most current during the 15 minute run time.



➢ 3D Depth Plot of Bathymetric Measurements correlated with latitude and longitude coordinates within Spring Lake following Path Plan.



➢ 2D Contour Plot of Bathymetric Measurements outlining path plan. Blue color showing the deepest part of lake, warmer color showing shallow areas of lake.

Conclusion

Our path plan algorithm and data points logged efficiently provide reliable data that can be visualized and represent viable data to be interpreted by professionals. Our autonomous USV system shows sustainability and economic solution for monitoring the aquatic ecosystem.

Acknowledgments

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