Autonomous Surface Vessel (ASV): Field Testing and Sensor Integration

Ryan Monroe, UNC Charlotte

Dr. Artur Wolek, Alex Nikonowicz | Department of Mechanical Engineering & Engineering Science

Introduction

This study evaluates the utility of deploying small, portable autonomous surface vehicles (ASVs) to collect in-water measurements of interest, such as water depth and water quality, in our state rivers, ponds, and lakes. The Hydrone ASV is evaluated through field work to determine its capability to conduct surveys of small sections of lakes and rivers and create interpolated maps describing the spatial distribution of the water quality parameters. The research also supported a NCDOT project to collect bathymetry data using a single beam echosounder. Additionally, a MATLAB/Simulink model of the Hydrone ASV was developed to predict the mission time required to follow a waypoint mission path in the presence of water currents.

Objectives

Mount Sonde to ASV

- Be able to integrate onto multiple ASV frames securely and in an easily attachable and detachable manner

Collect Conductivity/Salinity, Dissolved Oxygen (DO), Algae, and Turbidity data

Demonstrate effectiveness of multiparameter sonde's ability to collect and record water quality data onboard ASV.

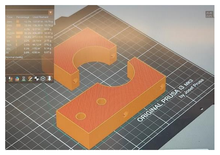
Correlate sonde data with bathymetry data

ASV Dynamic Model in Simulink

Control and visualize the heading of the ASV using a PID controller to optimize path motion and changes in direction

Method

Mount Design



- A 3D-printed, custom-designed mount of two parts clamped together onto the ASV frame secures the sonde in place for field usage

Data Collection method for sonde data

- Used Kor software to record data of conductivity, DO, algae, and turbidity via Bluetooth from sonde to computer application; used HyPack software to collect bathymetry data hardwired from echo sounder

PID-integrated control system in MATLAB/Simulink

- The thrust on the left and right motors was differentially controlled using 20 kg mass model of an ASV with a max thrust of 20 N

Collected Data

Hechenbleikner Lake

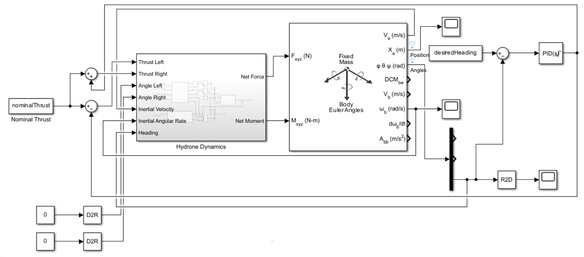
- Data from all four sensors, including Turbidity, Conductivity, Dissolved Oxygen, and Temperature were successfully collected over the course of 6min 47s, at a speed of 2 ft/s.

Data from ASV in Simulink

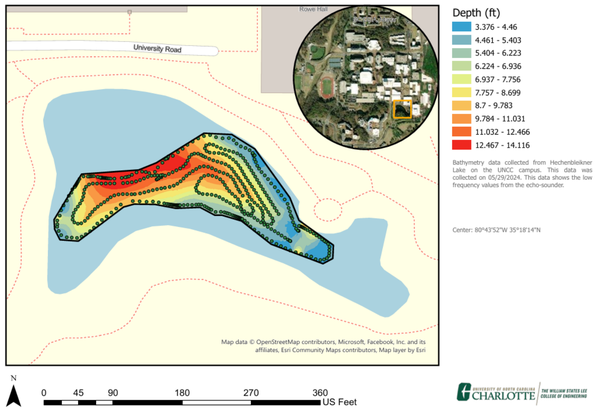
- The model executed up to 90 degree starboard and portside turns given consistent mass and differential thrust in less than 10 seconds.

Results

Simulink wiring diagram

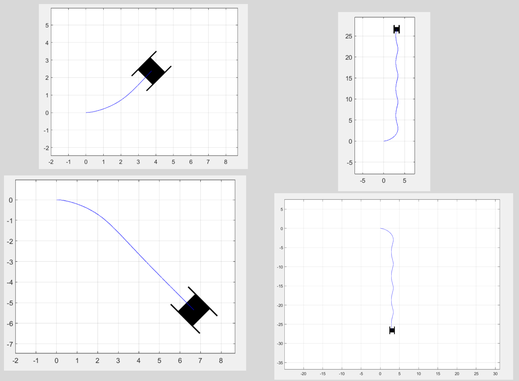


Contour Map of Hechenbleikner Lake



Sonde mounted onto 3 different ASVs

Sonde collecting data onboard ASV at Hechenbleikner Lake



*ASV model performing a 45 and 90 degree turns in Simulink**

Conclusions

The results at Hechenbleikner Lake demonstrate the effectiveness and low-effort costs of data collection utilizing ASV's navigation capability paired with a multiparameter sonde.

The bathymetry data can be compared with the sonde data to aid in water quality assessment. A winch-deployable system, where the bathymetry data safely guides the sonde's position during data collection would enhance this effort.

The Simulink model demonstrated efficient navigation using a PID controller. A future area for development would be to integrate a PID controller onto the ASV for enhanced data collection and path planning.

References

*Credit to Alex Nikonowicz for producing the contour map from the data retreived

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