Open-source unmanned surface vehicle (USV) for mobile acoustic telemetry

Xiaobo Tan[2], Eric Gaskell[2], Tyler R. Funnell[3], Christopher M. Holbrook[3], and Darryl W. Hondorp[4]

2 Department of Electrical and Computer Engineering, Michigan State University, 428 S. Shaw Lane, Rm. 2120 Engineering Building, East Lansing, MI 48824

3 Hammond Bay Biological Station, United States Geological Survey, 11188 Ray Rd., Millersburg, MI 49759

4 Great Lakes Science Center, United States Geological Survey, 1451 Green Rd., Ann Arbor, MI 48105

March 2024

ABSTRACT:

This project sought to advance Unmanned Surface Vehicles (USVs) as a practical and cost-effective mobile telemetry solution by understanding its acoustic tag detection performance over a range of operating conditions and developing optimal survey designs based on the detection characteristics. To characterize the tag detection performance, a USV with a mounted acoustic receiver was tested in two different operating modes, drifting versus station-keeping, while traversing a set of waypoints at Hammond Bay on Lake Huron. It was found that the USV under the drifting mode, with its thruster turned off after reaching a waypoint, demonstrated detection performance comparable to stationary receivers; on the other hand, in the station-keeping mode, where the USV attempted to hold its position by activating the thruster whenever needed, the detection performance was much worse. These findings established the viability of using a USV for mobile acoustic telemetry. A systematic approach to the design of USV waypoints was further developed based on the characterized detection efficiency curve. A multi-objective optimization tool was adopted to balance the trade-off between maximizing the coverage and minimizing the travel distance of the USV. A novel Bayesian estimation scheme was proposed to localize the tags based upon the captured and missed detections by the single receiver on the USV. Both simulation and experimentation were conducted to evaluate the proposed approach. Finally, a workshop was conducted at the 2024 Great Lakes Acoustic Telemetry Observation System (GLATOS) annual coordination meeting to disseminate the research findings and share with the attendees how to build and use a USV for mobile acoustic telemetry.