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Integration and Optimization Of UUV/USV Operations in Environmental Characterization

Joseph, John; Horner, Doug; Joseph, John; Horner, Doug; Nott, Bradley

Monterey, California. Naval Postgraduate School

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INTEGRATION AND OPTIMIZATION OF UUV/USV OPERATIONS IN ENVIRONMENTAL CHARACTERIZATION

PIs: John Joseph and Doug Horner

Authors: John Joseph[1], Doug Horner[2] and Bradley Nott[3]

[1]Oceanography Dept, [2]Mechanical & Aerospace Eng Dept, [3]USW Student

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Background

A study of the integration of unmanned surface vehicles (USVs) and unmanned underwater vehicles (UUVs) in support of wide-area environmental sensing and characterization was proposed by CNO N2/N6. N2/N6E is contemplating the development of a USV program under the Littoral Battlespace Sensing Program and this study is providing information to support program planning, policy and strategy development, organizational support and lessons learned.

In response to the N2/N6 proposed topic, this study examines cooperative use of small remotely-managed undersea gliders and unmanned surface vehicles to provide the warfighter with critical real-time environmental characterization, both oceanographic and acoustic, for extended (multi-month) periods of on-scene operations. The long-endurance capability allows the system to operate protracted independent missions, minimizing any burden it would otherwise impose on in-theater assets required to support it. To attain the capability in an integrated system, both the USV and UUV components must have "long legs". Our hypothesis is that an integrated system with reliable long-endurance characteristics will result in an operational capability that leverages the strengths of the individual platforms while mitigating their limitations and thus be a more effective force-multiplier than if the components were deployed independently.

Process

Our comprehensive program of theoretical, modeling and observational studies provides insight into the strengths and limitations of an integrated UUV/USV system to conduct timely wide-area environmental assessment applicable to Undersea Warfare and Battlespace Awareness missions.

Our approach has been to conduct an extensive literature search on various types of USV and UUV systems and their applications in research and industry to understand the potential capabilities that can be valuable to the system we envision. We are also comparing our physics-based propagation modeling results against real-world acoustic datasets collected in a representative mid-latitudes ocean environment. A deep-diving (>1000m) Spray glider was used to collect both oceanographic profiles and receive signals transmitted from a shallow mid-frequency source. A similar effort to collect acoustic communications signals is forthcoming and again will be compared with model results to demonstrate that, with appropriate environmental information, system performance of an integrated USV/UUV system can be well predicted and optimized.

We are also in the process of modifying NPS UUV/USV platforms that will be used to conduct testing under near-operational conditions.

Findings and Conclusions

Our literature search has found numerous applications of UUV and USV platforms being used in research, industry and the military, most of which demonstrate individual platforms working independently. However, there is much valuable information to glean from these efforts. There are also examples of cooperative behavior between USV and UUV platforms that have been successfully demonstrated which have been helpful in shaping our understanding of what may work and where we may run into some challenges. We have been fortunate to tap into assistance and expertise from colleagues at Scripps Institution of Oceanography (SIO) and the Monterey Bay Aquarium Research Institute (MBARI) that have guided us towards our current approach. Based on the current state of research in this area and the preliminary data sets we've gathered thus far, we are confident our approach has potential to lead to a relevant, capable integrated UUV/USV system, however more work needs to be done to iron out the details.

Recommendations

Continued development of the system we envision is highly recommended. This study is laying the essential groundwork for development of a credible, long-endurance, remotely piloted integrated UUV/USV system based on exploiting the local environment. Recommended future work should include addressing technical details that still need to be resolved and additional field testing under various real-world environmental conditions to ensure full functionality is attained.