Department of the Navy SBIR/STTR Transition Program

Pending SYSCOM Review

Topic # N19A-T022

Local Stochastic Prediction for UUV/USV Environmental Awareness

Applied Ocean Sciences

WHO

SYSCOM: ONR

Sponsoring Program:

Transition Target: Primary transition of results will be to Unmanned Vehicles Operations programs.

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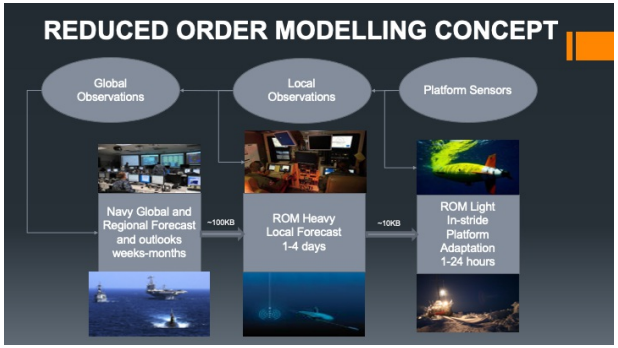
Other transition opportunities: This technology can also be used for surface and air mission planning and autonomy applications by adapting input fields and target parameters. This will enable transition to a wider range of programs within NAVAIR and NAVSEA scopes.



Notes: The figure above shows a schematic with the components of the Reduced Order Modeling (ROM) system to be implemented for UUV/USV network environmental awareness. This project develops solutions to be included in the central and right boxes using Dynamic Modal Decomposition of ocean fields from numerical simulations and then uses non-intrusive filters for local in-stride forecast reconstruction and machine learning based data assimilation.

WHAT

Operational Need and Improvement: In order to enable underwater autonomy along time spans of weeks to months, Navy operations need ocean predictions that usually exist among data files of the order of MB to GB to be rapidly delivered to UUV fleets and operations centers using files sizes of 100KB to 10KB, with the relevant environments and uncertainties These are to be used to enable local in-stride assimilation of local observations and as inputs for path optimization and sensor performance estimation/mission optimization.

Specifications Required: Technical solution needs to be compatible with autonomy designs being tested and implemented within the Navy and should include a light version of the system coded on Single Board Computers (SBC) to match different Size, Weight and Power (SWaP) constraints, for vehicles payload integration.

Technology Developed: This work delivers a software solution that enables the distribution of ocean fields (and other associated surfaces) updates and in-stride data assimilation to forward deployed platforms or teams constrained by bandwidth limitations using files of order 10-100KB. The same principles apply to the distribution of very large sets of files describing environmental uncertainties (e.g. ensemble distributions). The tools run both at control centers and on-board Underwater and Surface Unmanned Vehicles (UUV/USV). The technology uses a dynamic mode decomposition analysis and artificial intelligence to achieve a Reduced Order Modeling (ROM) solution for both file distribution and local in-stride assimilation of observations. The ROM products update a local ocean picture, valid for the time ranges the ROM modes persist (periods from 5-7 days and up to several months) and target primarily the variables and parameters of relevance for the UUV/USV missions planning and execution (e.g. sound speed and currents).

Warfighter Value: This technology delivers a critical requirement for long range underwater autonomy. By delivering environmental updates that could be broadcasted using small size signals and in-stride assimilation of local data, this technology enables underwater vehicles to optimize battery usage, sensor usage and route along missions requirements using small to none supervision for long time periods (order weeks to months).

WHEN

Contract Number: N68335-20-C-0567 **Ending on:** July 29, 2022

Milestone	Risk Level	Measure of Success	Ending TRL	Date
ROM mode-based and data assimilation solutions	Low	Solutions capable to use mode basis to reduce file sizes of MB to KB and perform local data assimilation using laboratory data	TRL 3	4th QTR FY21
Mode-based analysis and data assimilation ready for UUV/SUV integration	Low	Solutions capable to run on small and low power consumption boards and interface with vehicles señor data	TRL 4	4th QTR FY22
ROMS integration (light system and reachback solutions)	Med	System integrated with concepts of operations of Navy UUV/SUV missions	TRL 5	4th QTR FY23
Mission demonstrations of ROM solutions within relevant environments	Med	System successfully demonstrated during long range UUV missions	TRL 6	4th QTR FY24

HOW

Projected Business Model: MIT and AOS will work with UUV developers to build final solutions with the light version for payload integration using the ROM solutions interfacing with mission planning and vehicles sensors. These solutions will then be tested during identified ONR sea tests and end-to-end simulation systems. Final results will set protocols for UUV and mission planning and enable to design payloads that can be offerer to final customers. A heavy version solution will also be delivered for users with larger bandwidth and wider data sets access that can be used for wider applications that use environmental inputs for optimization of ship-aircraft routing, acoustic and drifting sensors placement and operations and in particular when capable to benefit form the inputs of large size ocean and atmosphere ensembles that cannot be distributed rapidly within operational time constraints.

Company Objectives: The short term objective is the AOS and MIT partnership to deliver and maintain capabilities to Navy customers with rapid solutions for local environmental adaptation and enable long endurance autonomy. AOS is company that has also major skills in acoustic modeling, sonar prediction, signal processing, bio-acoustics, atmospheric sciences and on implementing environmental artificial intelligence/optimization solutions to practical Navy problems. AOS has also been delivering unique underwater soundscapes/noise predictions within several projects. As such another objective will be to have the AOS-MIT team studying solutions to wider Navy requirements and implement these new ROM solutions to expedite distribution of information and local in-stride processing for large multi-disciplinary applications within battlespace optimization and Initial Preparation of Environments, combining air-surface-underwater assets for mission effectiveness.

Potential Commercial Applications: Payloads for UUV manufacturers for long range mission planning and optimization. Tool kits for interacting with large number of files used in. ensemble forecasting and extract targeted information in small size files. Software for aircraft path planning. Present solutions interface with Navy prediction systems and a public version will also be thought to interface with public data sets. AOS and MIT will also work together on pursuing additional applications within aircraft and UAV mission planning and execution.

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