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Manned-Unmanned Teaming in Distributed Maritime Operations

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MANNED-UNMANNED TEAMING IN DISTRIBUTED MARITIME OPERATIONS

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NPS NRP Executive Summary

Manned-Unmanned Teaming in Distributed Maritime Operations

Report Date: 12/31/19 Project Number (IREF ID): NPS-19-N112-A

Naval Postgraduate School Graduate School of Operational and Information Sciences

EXECUTIVE SUMMARY

Project Summary

As a key tenet of distributed maritime operations (DMO), available manned and unmanned, surface and air, combatants and sensors require integration to serve as a cohesive, networked force despite their distribution through physical space-time. This research project works to understand how to best enable cohesive combatant-sensor integration for DMO and to model and outline the system capabilities and behaviors necessary for their integrated implementation.

Keywords: *distributed maritime operations, DMO, autonomy, combatant-sensor integration, simulation*

Background

As technologic sophistication continues to advance rapidly, a wide array of diverse robots, unmanned vehicles, and other intelligent systems continue to demonstrate unprecedented capabilities for extended, independent, and even collective decision making and action. Indeed, the technologic capabilities of many autonomous systems (AS) in operation today exceed the authority delegated to them by organizations and leaders.

In many skilled mission domains and demanding environmental circumstances, AS can outperform their human counterparts along many dimensions, yet they fall short in other ways. Hence, *integrated* performance, by autonomous systems and people *working together*, is superior in an increasing number of circumstances. This increasingly important phenomenon is referred to as *teams of autonomous systems and people* (TASP).

Such collaboration between autonomous systems and people represents an important element of DMO. Available manned and unmanned, surface and air, combatants and sensors require integration to serve as a cohesive, networked force despite their distribution through physical space-time. Such integration represents a considerable technical challenge and is distributed organizationally as well; that is, combatants and sensors are distributed across different organizations in addition to physical space-time. Cohesive combatant-sensor integration represents a considerable command and control (C2) challenge also, as a variety of different platforms, services, and even nations are likely to assert simultaneous control over the diverse combatants and sensors.

This research project works to understand how to enable cohesive combatant-sensor integration for DMO and to model and outline system capabilities and behaviors necessary for their integrated implementation.

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Findings and Conclusions

The research questions are pursued through the following major project tasks:

- Task 1: Research the academic, doctrinal, and professional literatures to understand the current state of the art and future trajectories of unmanned systems and DMO.
- Task 2: Identify and adapt a computational model to characterize the structure, behavior, and performance of manned and unmanned systems in DMO organizations.
- Task 3: Simulate the comparative structure, behavior, and performance of maritime operations today.

Key findings center on our successful establishment of a computational model to characterize the structure, behavior, and performance of DMO organizations. A state-of-the-art organization simulation system, developed originally at Stanford and validated over nearly three decades, is selected and employed to model a joint task force (JTF) conducting maritime operations. This JTF model is specified to represent a collection of current Navy platforms (e.g., carriers, destroyers, littoral combat ships) and both manned (e.g., F/A-18, MH-60) and unmanned (e.g., ScanEagle, Fire Scout, Triton) aircraft conducting intelligence, surveillance, and reconnaissance (ISR) missions. The JTF ISR model establishes a powerful baseline for comparison with alternate DMO organizations and approaches.

Key findings center also on simulation results produced by the JTF ISR model. Such results reflect an experiment design comprised of 24 different conditions, each specified with a unique computational model instance, simulated 50 times, and measured across a panel of eight performance variables. The degree of autonomy, level of interdependence, and organization of maritime operations all exert major effects on simulated JTF ISR performance. The results provide a huge and rich set of data and information that will be invaluable for examining and comparing alternate DMO organizations and approaches.

Recommendations for Further Research

We recommend future work to continue along the lines of this project. Specifically, the JTF ISR model can be extended to represent one or more alternate DMO organizations and approaches, which can be simulated to produce performance results for comparison with maritime ISR operations today. The most promising DMO organizations and approaches can then be examined in greater detail through laboratory experimentation using experienced naval officers and sailors, the results of which can then be examined in turn through operational testing onboard aircraft and ships at sea. Future research can also examine alternate missions (e.g., strike, air defense, surface warfare) that extend beyond ISR.

Acronyms

Autonomous Systems	AS
Command and Control	C2
Distributed Maritime Operations	DMO
Intelligence, Surveillance, and Reconnaissance	ISR
Joint Task Force	JTF
Teams of Autonomous Systems and People	TASP