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Using Virtual Environments to assess Human-Robot Teams during MAGTF Operations

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NPS NRP Executive Summary
Creating a Virtual Environment for Evaluating Manned Unmanned Teaming (MUM-T)
Report Date: 12/17/19 Project Number (IREF ID): NPS-19- M285-A
Naval Postgraduate School, School of Operational and Information Sciences (GSOIS)

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Creating a Virtual Environment for Evaluating Manned Unmanned Teaming (MUM-T)

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EXECUTIVE SUMMARY

Project Summary

With the emergence of robots on the battlefield, it is critical for the Marine Corps to tactically integrate existing unmanned assets with manned systems during Marine Air Ground Task Force (MAGTF) operations. In parallel, the Marine Corps must also look forward to identify capability gaps that future unmanned systems might address. To do both requires extensive field testing, which is often unfeasible and always costly. This effort proposes the use of virtual environments (VE), virtual reality (VR) and agent-based modeling to conduct scenario-based assessments of Manned-Unmanned Teaming (MUM-T) during combat operations.

To pursue such goals, the project examined a variety of relevant tactical scenarios where Marines and robots act in concert to achieve specific mission objectives. Such tactical scenarios are further assessed using deterministic combat simulations to create a valid methodology for behavior creation and assessment within each scenario-specific problem space. Support for a complete range of combat simulations was determined as a necessary part of VE design explorations since specific MUM-T tactics, techniques and procedures (TTPs) are expected to co-evolve constantly as sensor, communication and vehicle capabilities continue to improve. Such diversity was supported through establishment of the Naval Postgraduate School (NPS) Modeling Virtual Environments and Simulation (MOVES) Live Virtual Constructive (LVC) Laboratory for diverse simulation tools. Additionally, two general approaches for the coordination of Manned Unmanned Teaming (MUM-T) behaviors were considered, each beginning with a high-level description of expected behaviors; completion of the goal tasks indicates that combined human-robot teams have achieved a desired world state.

Keywords: *virtual environments, VE, virtual reality, VR, extensible three-dimensional, X3D graphics, SPIDERS3D, Institute for Electrical and Electronic Engineers, IEEE, Distributed Interactive Simulation, DIS, Live Virtual Constructive, LVC*

Background

This research surveyed a large variety of combat models and visualization tools to create the best and broadest possible environment for Marine Corps decision-makers to understand the complexity and warfighting value of the Manned-Unmanned Teaming (MUM-T) battlespace. Shared VEs can potentially be used during force-development efforts to plan for the integration of MUM-T into combat units. As the Department of Defense (DoD) is generally unfamiliar with such operations, but is eagerly anticipating their development, it is quite clear that the use of live,

virtual, constructive LVC simulations to wargame these capabilities becomes fundamental for all progress. Ultimately, such MUM-T co-development is the critical path needed to expand MAGTF capabilities and avoid MAGTF vulnerabilities.

The use of virtual environments for unmanned systems combines two of the biggest areas of research activity in the DoD; applying them to MUM-T places such work at the highest priority of 21st-century military challenges. Therefore, the use of LVC simulations to wargame these capabilities is fundamental. In parallel, the Marine Corps must identify the capability gaps of future unmanned systems. Our efforts have worked to achieve generality, scalability and functionality in all respects in order to meet such challenges.

Findings and Conclusions

This work examined a variety of relevant tactical scenarios where Marines and robots act in concert to achieve specific mission objectives. Such tactical scenarios were further assessed using deterministic combat simulations in order to create a valid methodology for behavior creation and assessment within each scenario-specific problem space. Support for a complete range of combat simulations was determined as a necessary part of VE design explorations, since specific MUM-T tactics, techniques and procedures (TTPs) are expected to co-evolve constantly as sensor, communication, and vehicle capabilities improve. These diverse simulation tools were supported through the MOVES LVC Laboratory at NPS. Additionally, two general approaches for the coordination of MUM-T behaviors were considered, each beginning with a high-level description of expected behaviors; completion of the goal tasks indicates that combined human-robot teams have achieved a desired world state. While Marines teaming with machines provide an essential margin on the battlefield, success will be determined by human effectiveness to harness and lead such teams.

Understanding of these capabilities will grow through rehearsal and testing in virtual environments, as a massive set of capabilities is emerging in these domains. Our diverse and integrative work on Institute for Electrical and Electronic Engineers Distributed Interactive Simulation (DIS) Protocol, Extensible 3D (X3D) Graphics International Standard, and the SPIDERS3D Virtual Environment, indicate that general solutions to this important challenge are possible. Additionally, the use of open standards (DIS, X3D) and open source (SPIDERS3D) means that diverse systems, models, streams and repeatable “lessons learned” can continue to grow more broadly and deeply.

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Recommendations for Further Research

In order for warfighters to fully understand the capabilities, limitations, risks and progress of this technology, virtual environments that integrate field experimentation, and modeling and simulation data streams using 3D models for visualization, should be used within a shared collaborative network. Interoperable Web standards ensure that specialty systems can bridge together compatibility, rather than languishing as unusable disconnected blocks of isolated functionality; prototype work in this project shows great potential for broad and repeatable solutions to these critical problems. All future work should be grounded by LVC interoperability testing, to ensure that global progress can continue, avoiding the "stovepipe" constraints that limit many current approaches.

Acronyms

Live Virtual Constructive	LVC
Marine Air Ground Task Force	MAGTF
Modeling Virtual Environments and Simulation	MOVES
Manned-Unmanned Teaming	MUM-T
Naval Postgraduate School	NPS
tactics, techniques and procedures	TTP
virtual environments	VE
virtual reality	VR
Extensible 3D (X3D) Graphics International Standard	X3D