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U.S. ARMY RDECOM

Meta-Cognition, Self-Reflection and Proprioception

open campus

S&T Campaign: Sciences for Maneuver
Vehicle Intelligence

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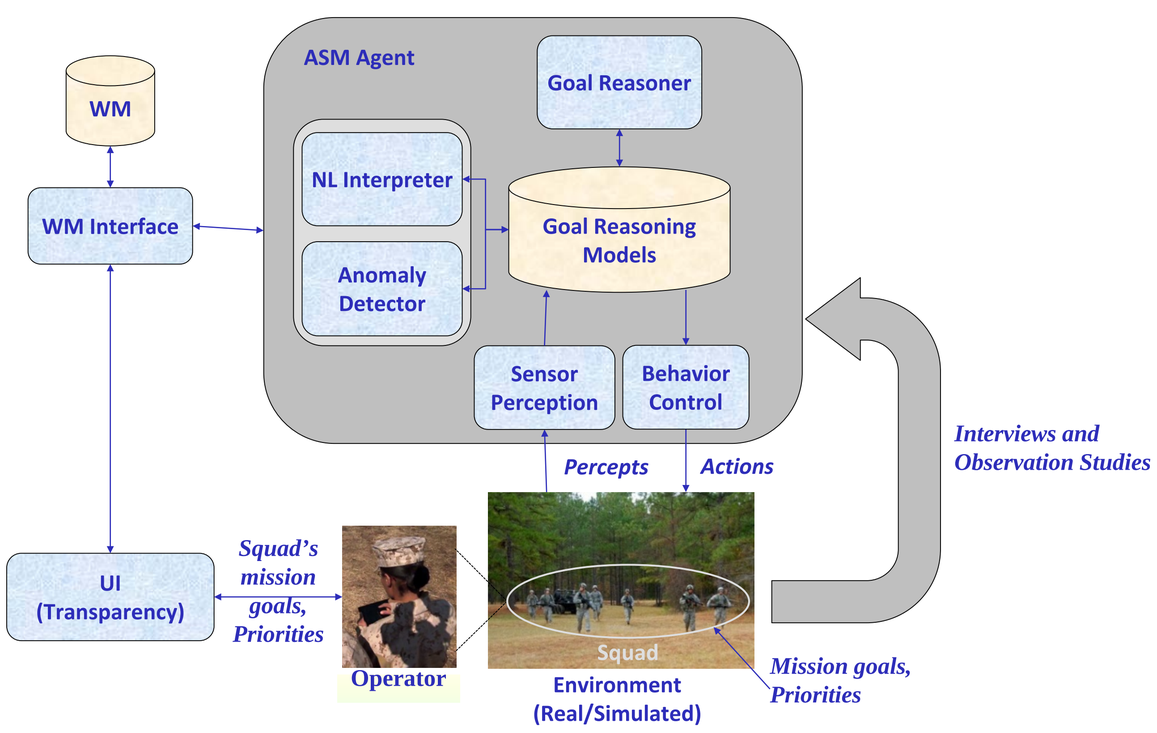
Research Objective

Develop technologies that enable an autonomous system to recognize transitions between normal operations and behaviors to abnormal operations and behaviors for both itself and its team. Enable the system to adjust its behavior to support the squad's dynamically changing goals.

Current autonomous systems cannot participate in squad missions that require them to dynamically adjust their behavior to support the changing goals of a squad.

Challenges

- **Collecting data on coordinated activities**
- **Developing predictive models for military team behaviors from incomplete observations**
- **Aligning robot actions with overall team goals**

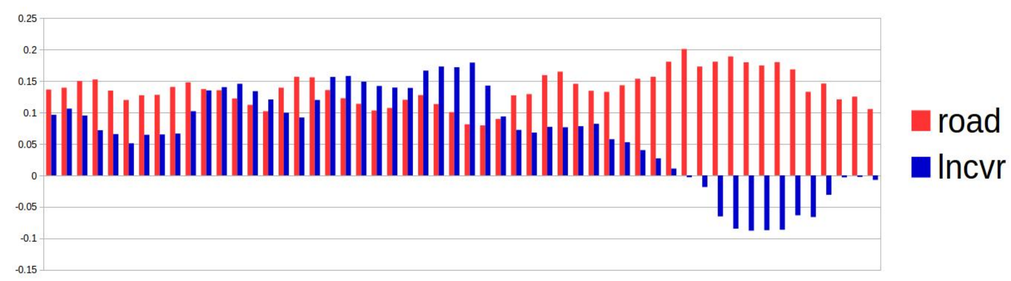


Effective human/robot team behavior requires the robot to model the behavior of its teammates as individuals and as a group. Our current research concentrates on building predictive models of military team behavior from incomplete observations.

ARL Facilities and Capabilities Available to Support Collaborative Research

- **Large indoor facilities for controlled mobility and perception testing; access to outdoor testing facilities**
- **Multiple ground robots with diverse sensors**
- **High-fidelity battlefield simulation tools**
- **High performance computing assets**
- **Access to Soldiers and military units**
- **Partnerships with the Naval Research Laboratory and the ARL Human Research and Engineering Directorate**

Detecting a Change in Movement Strategy



Blue *persistently* violates its apparent strategy.

Relevant Publications

- **Owens, J., Osteen, P., & Daniilidis, K. "MSGCal: Multi-sensor graph-based Calibration" accepted for presentation at the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2015), Hamburg, Germany, September 28 - October 02, 2015.**
- **Wimpey, B. , Lennon, C., & Fields, M.A., "Detecting Team Behavior Using Focus of Attention" accepted to appear in the Proceedings of the Winter Simulations Conference, Dec. 2015.**
- **Pulido, J.V., Lennon, C., Fields, M.A., Barnes, L., Constructing a Movement Model for a Small Unit (2015). Proceedings of the 2014 Conference on Applied Statistics in Defense; to appear in Proceedings of the 2015 Joint Statistical Meetings, Seattle, WA.**
- **Tron, Osteen, P., Owens, J., Daniilidis, K., *Pose Optimization for the Registration of Multiple Heterogeneous Views*. Robotics Science and Systems, 2014.**
- **Garcia, R., Barnes, L., and Fields, M.A., "Unmanned Aircraft Systems as Wingmen." *The Journal of Defense Modeling and Simulation: Applications, Methodology, Technology* 9.1 (2012): 5-15.**
- **Fields, M.A., et al. "Effective robot team control methodologies for battlefield applications." *Intelligent Robots and Systems, 2009. IROS 2009. IEEE/RSJ International Conference*. IEEE, 2009.**

Complementary Expertise/Facilities/ Capabilities Sought in Collaboration

- **Unsupervised learning**
- **Activity recognition**
- **Dynamic scene understanding**
- **Goal reasoning**
- **Statistical relational learning**
- **Multisensor fusion**
- **Reasoning in partially observed environments**
- **Online performance measurement and analysis**

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