Science of Autonomy

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At a Glance

What is it?

- Addresses critical multi-disciplinary autonomy challenges that cut across different ONR departments and warfighting areas/domains including air, sea, undersea, and ground.

How does it work?

- Focused on four interrelated areas of (1) Human Collaboration with Autonomous Systems, (2) Perception and Intelligent Decision-Making, (3) Scalable Distributed Collaboration, and (4) Intelligent Architectures
- Develops collaborations between researchers in different autonomous system domains that have traditionally been somewhat separated (air, sea, undersea, ground), control theory, computational intelligence, human factors, biology, economics, cognitive science/psychology and neuroscience

What will it accomplish?

- Autonomous operations in many naval domains, for many mission types, and on multiple platforms that can (1) Operate as part of a hybrid force with manned systems and platforms, (2) Maintain survivability through decentralized assets/redundancy, (3) Reduce the need to place personnel and high value assets in high-threat areas, (4) Reduce manning and comms requirements, and (5) expand the operational envelope of Naval forces, provide force multiplication, or replace existing capability with a less expensive alternatives.

Points of Contact

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The Science of Autonomy effort addresses critical multi-disciplinary research challenges that cut across different ONR departments and warfighting areas/domains. This involves different autonomous system domains that have traditionally been somewhat separated (air, sea, undersea, ground), control theory, computational intelligence, human factors, and related fields such as biology/animal behavior/ cognition, economics/management theory, cognitive science/psychology, and neuroscience.

The research is focused on making progress on a set of autonomy technical challenges that were identified in a series of ONR/NRL workshops. The challenges are in the four interrelated areas of Human Collaboration with Autonomous Systems, Perception and Intelligent Decision-Making, Scalable Distributed Collaboration, and Intelligent Architectures. These challenges need to be addressed relative to critical aspects of the naval domain including (1) Operations in spatially and temporally variable and uncertain environments with limiting manning, communications, and other resources, (2) Users with a wide range of skills and experience including getting unmanned system services to support small tactical units, (3) Diverse environments encompassing air, sea surface, undersea and ground systems and hybrid concepts in between, (4) Platforms with highly limited and intermittent communications, (5) Complex missions with heterogeneous platforms and sensors including significant differences in physical and sensing capabilities, (6) Rapid and dynamic responses to user needs and changes in the operating space, and (7) The need for automation to explain its capabilities to the user and reliably execute the required tasks in the required time.

Examples of multi-disciplinary research include (1) a control engineer working with a neuroscientist to develop spatial understanding approaches for autonomous systems that fit human semantic models and could be used to create UAV “wingmen” for dismounted Marines, (2) biologists and engineers using models of social interactions in animal groups that allow individuals to access higher-order computational abilities at the collective level and make good decisions despite uncertainty, (3) biologists, psychologists, and engineers applying behavioral & cognitive models of predator-prey relationships to engineered systems for ISR of large, complex areas by heterogeneous unmanned systems.

Research Challenges and Opportunities:

- Scalable, self-organizing, survivable, organizational structure/hierarchy of heterogeneous UxVs appropriate to naval mission domains
- Autonomous learning, reasoning, and decision-making in unstructured, dynamic, and uncertain environments
- Human interaction/collaboration including understanding intent and actions of human team members, adversaries, and bystanders
- Organic perception/understanding to support decision-making, reasoning, and actions in a complex, dynamic world