Opportunity Title: Multi-Agent Control Hierarchy for Distributed Space Systems
Opportunity Reference Code: ICPD-2021-30

Organization Office of the Director of National Intelligence (ODNI)

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Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orise.orau.gov/icpostdoc/index.html.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 2/26/2021 6:00:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

It is hypothesized that distributed space-based Intelligence, Surveillance, and Reconnaissance (ISR) systems working cooperatively reduce timelines for data processing and increase overall efficiency of the architecture. To achieve these outcomes, however, the architecture's Task/Collect/Process/Exploit/Disseminate (TCPED) cycle must be managed in real time across the systems. The simplest conceptual approach from a control point of view would be to have a centralized agent that schedules all systems across the architecture; however, this is not practical since the singular agent would require awareness of all data and states across the architecture and would be difficult to scale to a large number of ISR platforms. The other extreme would involve a completely decentralized approach, but this would count on some form of self-organization to achieve cooperative behavior. The goal of this research topic is to explore and understand the challenges and benefits of implementing a multi-agent control hierarchy across the enterprise. What should be centralized in order to ensure cooperative behavior, but also limit communications and effectively scale to large numbers? How many control layers are needed for a given number of ISR platforms? What classes of algorithms are best suited at various layers of the control hierarchy?

Example Approaches:

Consider a fleet of robo-taxis, in which some the attributes of the robo-taxis vary like the services offered by current ride-sharing companies (e.g., small vehicle, large vehicle, luxury vehicle, etc.).Each robo-taxi would likely have its own master control agent that oversees the control agents responsible for the subsystems of the vehicle. Additionally, the fleet would also need a dispatcher that would task ride requests to the robo-taxis based on the attributes of the ride request (e.g., pick-up location, drop-off location, vehicle class, etc.) and some level of knowledge of the fleet location and abilities. It is possible that the dispatcher agent releases the task and the robo-taxis bid for it with some measure of projected reward to decide which taxi is scheduled. However, this leads to further questions such as; where is traffic taken into account? Does each robo-taxi need traffic knowledge to make a bid? Can the dispatcher take input from a global traffic agent to modify the bids? Trade studies will be needed to explore these questions. In terms of algorithms, reinforcement learning algorithms and particle or Monte Carlo methods may be

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appropriate at the dispatcher level. Greedy algorithms based on simple reward functions may be the most scalable for complex systems even if optimality is at risk.

Relevance to the Intelligence Community:

Autonomous, cooperative behavior among space-based ISR assets is an enabler to future timeliness and efficiency.

Key Words: Management Theory, Control Theory, Artificial Intelligence, AI, ISR, Intelligence, Surveillance, Reconnaissance, TCPED, Task/Collect/Process/Exploit/Disseminate Cycle

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (2 👁)
  - **Computer, Information, and Data Sciences** (17 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (45 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Other Non-Science & Engineering** (2 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (27 👁)