NASA STTR 2019 Phase I Solicitation

T4.01 Information Technologies for Intelligent and Adaptive Space Robotics

Lead Center: ARC

Participating Center(s): ARC

Technology Area: TA4 Robotics, Telerobotics and Autonomous Systems

Develop Information Technologies to Improve Space Robots

Extensive and pervasive use of advanced space robots can significantly enhance exploration and increase crew efficiency, particularly for missions that are progressively longer, complex, and distant. The performance of these robots is directly linked to the quality and capability of the information technologies used to build and operate them. With few exceptions, however, current information technology used for state-of-the-art robotics is designed only to meet the needs of terrestrial applications and environments.

The objective of this subtopic, therefore, is to encourage the adaptation, maturation, and retargeting of terrestrial information technologies for space robotics. Proposals are specifically sought to address the following technology needs:

- Advanced robot user interfaces that facilitate distributed collaboration, geospatial data visualization, summarization and notification, performance monitoring, or physics-based simulation. The primary objective is to enable more effective and efficient interaction with robots remotely operated with discrete commands or supervisory control. Note: proposals to develop user interfaces for direct teleoperation (manual control) are not solicited and will be considered non-responsive.
- Navigation systems for mobile robot (free-flying and wheeled) operations in man-made (inside the International Space-Station) and unstructured, natural environments (Earth, Moon, Mars). Emphasis on multi-sensor data fusion, obstacle detection, and localization. The primary objective is to radically and significantly increase the performance of mobile robot navigation through new sensors, avionics (including COTS processors for use in space), perception algorithms and software. Proposals for small size, weight, and power (SWAP) systems are particularly encouraged.
- Robot software systems that support system-level autonomy, instrument/sensor targeting, downlink data triage, and activity planning. The primary objective is to facilitate the creation, extensibility and maintenance of complex robot systems for use in the real-world. Proposals that address autonomy for planetary rovers operating in rough terrain or performing non-traditional tasks (e.g., non-prehensile manipulation) are particularly encouraged.

Information technology for intelligent and adaptive space robotics is highly cross-cutting:

- The technology can be applied to a broad range of unmanned aerial systems (UAS), including both small-scale drones and Predator / Global Hawk type systems. The technology can also be potentially infused into

other flight systems that include autonomous capabilities.
- The technology is directly relevant to "caretaker" robots, which are needed to monitor and maintain human spacecraft during dormant/uncrewed periods. The technology can also be used by precursor robots to perform required exploration work prior to the arrival of humans.
- The technology is required for future missions in Earth Science, Heliophysics, and Planetary Science (including the Moon, icy moons and ocean worlds) that require higher performance and autonomy than currently possible. In particular, missions that must operate in dynamic environments, or measure varying phenomena, will require the technology developed by this subtopic.
- The technology is directly applicable to numerous current mid-TRL (Game Changing Development program) and high-TRL (Technology Mission Development program) R&D activities, including Astrobee, In-space Robotic Manufacturing and Assembly, etc.

Proposers should develop technologies that can be demonstrated with or integrated to existing NASA research robots or projects to maximize relevance and infusion potential. Deliverables:

- Identify scenarios, use cases, and requirements.
- Define specifications.
- Develop concepts and prototypes.
- Demonstrate and evaluate prototypes in real-world settings.
- Deliver prototypes (hardware and/or software) to NASA.

The expected Technology Readiness Level (TRL) range at completion of the project is 4-5.

References:

- https://www.nasa.gov/astrobee
- https://robonaut.jsc.nasa.gov
- J. Crusan, et al. 2018. "Deep space gateway concept: Extending human presence into cislunar space", In Proceedings of IEEE Aerospace Conference, Big Sky, MT.
- M. Bualat, et al. 2018. "Astrobee: A new tool for ISS operations". In Proceedings of AIAA SpaceOps, Marseille, France.
- T. Fong, et al. 2013. "Smart SPHERES: a telerobotic free-flyer for intravehicular activities in space". In Proceedings of AIAA Space 2013, San Diego, CA.
- M. Diftler, et al. 2011. "Robonaut 2 - The first humanoid robot in space". In Proceedings of IEEE International Conference on Robotics and Automation, Shanghai, China.