NASA SBIR 2011 Phase I Solicitation

O3.01 Remotely Operated Mobile Sensing Technologies for inside ISS

Lead Center: ARC

Participating Center(s): JPL

This subtopic seeks proposals to develop technologies that advance capabilities for space telepresence and mission operations situation awareness, fault diagnosis, isolation, and recovery onboard the ISS using an onboard free-flyer as a mobile sensor platform. In order to increase productivity and reduce risks on long-missions on spacecraft, such as the ISS, leading toward human exploration, commercialization, and colonization of space, ground personnel have a need to remotely command a wide-variety of sensors on mobile platforms to collect data from a variety of positions within spacecraft. The sensors include, but are not limited to, those capable of performing imaging, identifying inventory, and measuring electromagnetic radiation, temperature, acoustics, atmospheric properties, and chemical concentrations. To increase crew productivity, it is highly desirable that the mobile platform be capable of being deployed by ground command, move to the commanded location, collect data, and then return to its storage dock where it is recharged all without requiring crew assistance.

This subtopic solicitation calls for developing a variety of software and hardware technologies that would enable a free-flyer to operate in multiple modules inside ISS including but not limited to:

- Free-flyer localization capability without engineering environment.
- Collision avoidance capability.
- Adjustable autonomous control software that supports safe operation with low-bandwidth, intermittent command communication loop with varying latencies > 10 sec.
- EXPRESS rack-based auto-docking, recharging, refueling, deployment mechanism with matching free-flyer mechanism.
- Quiet propulsion capability meeting ISS noise limit requirements (
- Vision-based object identification capability.
- RFID-based inventory identification capability.

Proposals may address any one or a combination of the above or related subjects.

Three SPHERES satellites have operated inside ISS since 2006. In addition to performing dozens of experiments, these satellites demonstrate that mobile platforms in the form of free-flyers can be operated on ISS. However, these satellites have not been operated by ground personnel and their current design is inadequate to meet the needs described above for several reasons, e.g., the satellites require crew assistance to operate, require that batteries and CO_2 cartridges (propellant) be replaced by crew between test sessions, and are confined to a work area bounded by external beacons used by the satellites to localize themselves within their workspace, approximately 2x2x2 meters. However, the SPHERES satellites may be useful in demonstrating technologies called for by this subtopic. Proposals are encouraged that leverage the SPHERES satellites operating onboard ISS and SPHERES engineering units at the NASA Ames Research Center. More information on SPHERES is at:

- http://www.nasa.gov/mission_pages/station/research/experiments/SPHERES.html.
- http://ssl.mit.edu/spheres.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase II contract.

Phase I Deliverables:

- Midterm Technical Report.
- Final Phase I Technical Report with a feasibility study including: simulations and measurements demonstrating the approach used to develop and test the prototype, constraints on other systems, concept of operations, verification matrix of measurements with pass/fail ranges for each quantity to be verified at the end of Phase II, and the Phase II integration path.
- Proof-of-concept simulation and/or bench top demonstration (TRL 3-4).

Phase II Deliverables:

- Midterm Technical Report.
- Final Phase II Technical Report with specifications including: design, development approach, tests to verify the prototype, verification matrix of measurements with pass/fail ranges for each quantity verified, constraints on other systems, and operations guide. Opportunities and plans for potential commercialization should also be included.
- Fully-functional engineering prototype of proposed product (TRL 5-6).