NASA SBIR 2018 Phase I Solicitation

H10.02 Autonomous Control Technologies (ACT) for Ground Operations

Lead Center: KSC

Participating Center(s): ARC, LaRC, SSC

Technology Area: TA4 Robotics, Telerobotics and Autonomous Systems

Autonomous Control Technologies (ACT) are needed to reduce operations and maintenance costs of ground and payloadÂ operations and to increase the availability of systems to support mission operations. These technologies perform functions such as anomaly and fault detection, fault isolation, diagnostics and prognostics and enable variable levels of autonomous control and recovery of system operations, where recovery may include reconfiguration or repair. Autonomous Control Technologies are enabled by intelligent systems health management component technologies, methodologies, and approaches; command and control architectures; computing architectures; software for decision-making and control; and intelligent devices.Â

ACT will be applied to operations such as autonomous propellant management, which includes the transfer, storage, measuring, and sampling of cryogenic, or other propellant for use in launch systems without requiring human interaction.Â Propellant management includes pre-planned nominal capabilities such as vehicle fill and drain as well as contingency and off-nominal capabilities such as emergency safing, venting and system reconfiguration. ACT capabilities will enable the autonomous monitoring and control of the integrated system resulting from the loading system and all other associated systems involved in the loading process.Â Â The system autonomy software itself includes both prerequisite control logic (PCL) and reaction control logic (RCL) programming, and may utilize some form of machine learning, neural network, or other form of artificial intelligence to adapt to degraded system components or other form of off-nominal conditions. In addition to cryogenic and other propellants, propellant management systems may utilize additional commodities to prepare a vehicle for launch, such as high-pressure gases for purges, pressurization, or conditioning, and may include power and data interfaces with the vehicle to configure vehicle valves or other internal systems and utilize on-board instrumentation to gain visibility into the vehicle during loading.Â

ACT must also supportÂ tasks such as setup, testing and checkout, troubleshooting, maintenance, upgrades and repair. These additional tasks drive the need for autonomous element to element interface connection and separation, multi-element inspection, and recovery of high value cryogenic propellants and gases to avoid system losses.Â

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II demonstration, and delivering a demonstration package for NASA testing in operational or analog test environments at the completion of the Phase II contract.Â

Phase I Deliverables - Research, identify and evaluate candidate technologies or concepts for systems and components fault detection, isolation and recovery, fault prediction and diagnosis, and decision-making algorithms for control to enable autonomy of ground systems.Â Demonstrate the technical feasibility, and show a path

towards a demonstration. Concept methodology should include the path for adaptation of the technology, infusion strategies (including risk trades), and business model.Â It should identify improvements over the current state of the art for both operations and systems development and the feasibility of the approach in a multi-customer environment. Bench or lab-level demonstrations are desirable.Â Deliverables must include a report documenting findings.Â

Phase II Deliverables - Emphasis should be placed on developing, prototyping and demonstrating the technology under simulated operational conditions using analog earth-based systems including dynamic events such as commodity loading, disconnect or engine testing. Deliverables shall include a report outlining the path showing how the technology could be matured and applied to mission-worthy systems, functional and performance test results and other associated documentation. Deliverable of a functional prototype (software and hardware) is expected at the completion of the Phase II contract. The technology concept at the end of Phase II should be at a TRL of 6 or higher.