NASA SBIR 2021 Phase I Solicitation

Z3.05 Satellite Servicing Technologies

Lead Center: GSFC

Participating Center(s): LaRC, MSFC

Scope Title:

Adjustable End-of-Robot-Arm Force-Torque Sensor Technique

Scope Description:

Technology development efforts are required to enable on-orbit servicing, assembly, and manufacturing (OSAM) for commercial satellites, robotic science, and human exploration. OSAM is an emerging national initiative to transform the way we design, build, and operate in space. The goal of the initiative is to develop a strategic framework to enable robotic servicing, repair, assembly, manufacturing, and inspection of space assets. An end-of-arm force-torque sensing technique that is adjustable is needed to enable a variety of OSAM mission-specific tasks to be performed. A ground-based demonstration of the technique is of interest.

Current state of the art in end-of-arm force-torque sensors is that they are not placed close enough to the sensing point to minimize the load distal of the sensor, do not work in both unrestricted 1g and 0g environments, and cannot simultaneously handle large (6× to 10×) full-range overload for launch loads while providing absolute accuracy stability for at least 30 min before zeroing. A sensing technique is needed that can provide the following:

- Range of 0 to 200-500 N, resolution of 2 N, and absolute accuracy of ±5 N for surface contact measurements.
- Range of ±120 N, resolution of 0.1 N to 0.2 N, and absolute accuracy of ±2 N for servicing tasks.
- Range of 0 to 20 N, resolution of 0.02 N, and absolute accuracy of ±0.1 N for payload determination measurements.

Expected TRL or TRL Range at completion of the Project: 2 to 4

Primary Technology Taxonomy:
Level 1: TX 04 Robotics Systems
Level 2: TX 04.1 Sensing and Perception

Desired Deliverables of Phase I and Phase II:

- Analysis
- Prototype
- Hardware
- Software
Desired Deliverables Description:

Phase I deliverables include:

- Background research and feasibility studies.
- Modeling to demonstrate feasibility.
- Conceptual design, trade studies, and description of proposed solution.
- Demonstrations of subsystems or key technologies.
- Pathfinder technology demonstrations.
- Brassboard force-torque sensor.

Phase II deliverables include:

- Demonstration using the brassboard force-torque sensor.
- Environmental testing of key components.

State of the Art and Critical Gaps:

Current state of the art in end-of-arm force-torque sensors is that they are not placed close enough to the sensing point to minimize the load distal of the sensor, do not work in both unrestricted 1g and 0g environments, and cannot simultaneously handle large (6× to 10×) full-range overload for launch loads while providing absolute accuracy stability for at least 30 min before zeroing.

Relevance / Science Traceability:

An adjustable force-torque sensor is relevant to dexterous robotic missions such as OSAM-1, OSAM-2, International Space Station (ISS) robotics, robotic sample return missions, Gateway, and In-Space Assembled Telescope.

References:

On-Orbit Satellite Servicing Study Project Report, October 2010, 

Scope Title:

Centralized Robot Actuator Servo Controller Board for MUSTANG (Modular Unified Space Technology Avionics for Next Generation) Form Factor

Scope Description:

Technology development efforts are required to enable on-orbit servicing, assembly, and manufacturing (OSAM) for commercial satellites, robotic science, and human exploration. OSAM is an emerging national initiative to transform the way we design, build, and operate in space. The goal of the initiative is to develop a strategic framework to enable robotic servicing, repair, assembly, manufacturing, and inspection of space assets. A robot actuator servo control electronic board that fits in the Modular Unified Space Technology Avionics for Next Generation (MUSTANG) form factor is needed to enable a variety of OSAM and robotic sample return missions. A ground-based demonstration of the control electronics is of interest.

Current state of the art for robot actuator servo control electronic boards is that they do not read all of the sensors necessary for closed-loop control, are too big (>30 by 30 cm), and weigh too much (>2 kg). An actuator servo control electronic board is needed that fits the MUSTANG form factor, reads all of the necessary sensors (Hall effect sensor, resolver), and weighs less than 2 kg.

Expected TRL or TRL Range at completion of the Project: 2 to 4

Primary Technology Taxonomy:

Level 1: TX 04 Robotics Systems
Level 2: TX 04.3 Manipulation

Desired Deliverables of Phase I and Phase II:

- Analysis
- Prototype
- Hardware
- Software

**Desired Deliverables Description:**

Deliverables include a ground-based demonstration of a robot actuator servo control electronic board in the MUSTANG form factor commanding a robot actuator.

Phase I deliverables include:

- Background research and feasibility studies.
- Modeling to demonstrate feasibility.
- Conceptual design, trade studies, and description of proposed solution.
- Demonstrations of subsystems or key technologies.
- Pathfinder technology demonstrations.
- Brassboard robot actuator servo control electronic board.

Phase II deliverables include:

- Demonstration using the brassboard robot actuator servo control electronic board.
- Environmental testing of key components.

**State of the Art and Critical Gaps:**

Existing centralized robot actuator servo control electronics do not fit the MUSTANG form factor or require additional resources other than those provided by the rest of the MUSTANG avionics platform.

**Relevance / Science Traceability:**

Robot actuator servo control electronics are relevant to dexterous robotic missions such as OSAM-1, OSAM-2, International Space Station (ISS) robotics, robotic sample return missions, Gateway, and in-Space Assembled Telescope.

**References:**

On-Orbit Satellite Servicing Study Project Report, October 2010, 

MUSTANG (Modular Unified Space Technology Avionics for Next Generation): [https://ntrs.nasa.gov/citations/20190028692](https://ntrs.nasa.gov/citations/20190028692)