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ULTRA-CLOSE RPO ON-ORBIT DEMONSTRATION OF ADRAS-J PROGRAM

**Abstract**

As a result of over 60 years of space exploration, space environmental problems have become serious. The upper stages of rockets and satellites that have completed their missions remain on orbit, causing an increase in the amount of space debris and increasing the risk of explosions and collisions. It has been several decades since the possibility of the Kessler Syndrome, in which increasing debris from collisions creates an increasing cascade of collisions, was first suggested, and collisions with debris have actually occurred, leaving the space environment in an unpredictable state.

To become a regular activity, the removal of space debris requires strong governmental support for its technical development and preparing for stable service provision. This requires funding for missions to develop the necessary technology, and active policy reform that will lead to safe and sustainable operations.

In March 2020, JAXA announced that it would fund the first phase of a mission line focused on the observation, characterization, and eventual removal of a large piece of Japanese space debris. The initial phase of the mission line includes the location, close approach, and rendezvous with a Japanese upper stage rocket body, followed by the acquisition of in-situ data to better understand the movement and other characteristics of the debris.

JAXA has selected Astroscale and its ADRAS-J (Active Debris Removal by Astroscale-Japan) program as the commercial partner for the first phase of this mission.

This paper explains the critical technology, the concept of operations, and the results of the on-orbit demonstration of the ADRAS-J program. Details are provided on the following mission enabling elements:

- a concept of operations to realize the RPO that includes the rendezvous, proximity approach, and proximity operation to the client;
- the RPO sensor suite to support short- and long-range RPO;
- Guidance Navigation and Control and Computer Vision algorithms essential for realizing closed-loop RPO maneuvers;
- supporting ground segment capabilities, such as the Flight Dynamics System to determine the position and the orientation of servicer and client;
- the operations required to plan and execute RPO on-orbit.

The ADRAS-J Mission launched in February 2024 and is the world's first un-prepared large debris observation mission with ultra-close proximity.

Key Words: Space Debris, ADR, CRD2, ADRAS-J, On-orbit Servicing