

Software-in-the-Loop Simulation For ADR Mission Using ROS/Gazebo

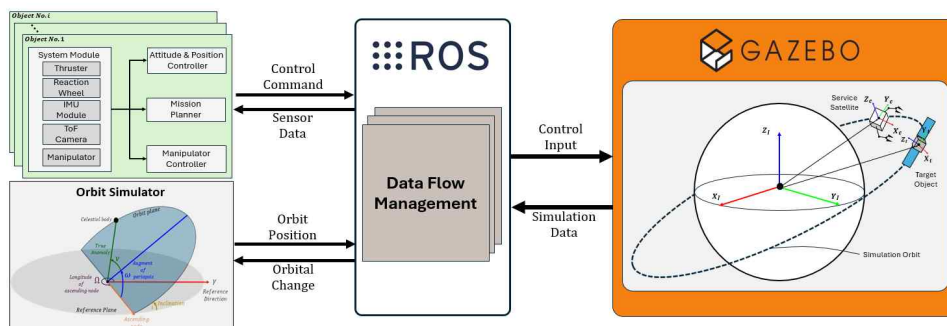
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Abstract

To successfully execute an ADR (Active Debris Removal) mission, various GNC (Guidance, Navigation, and Control) technologies are required, such as vision-based relative navigation, capture device operation, and satellite orbit and attitude control. While each technology can be individually developed and validated, a comprehensive mission simulation environment is necessary to verify the functionality and performance considering the interconnectivity of these technologies throughout the mission. Specifically, for satellites equipped with robotic arms, which need to account for multi-body dynamics, it is essential to consider modeling uncertainties, contact dynamics, and orbit propagation. To date, simulations that comprehensively consider these elements have not been reported in the literature.

In this study, we propose an integrated mission simulation framework called "AstroROS" utilizing ROS (Robot Operating System) and Gazebo. AstroROS comprises three main components: an orbit simulator, a data flow manager, and a physics simulator. The orbit simulator is equipped with specialized libraries for precise calculation of the mission satellite's orbit. The data flow manager oversees all data generated during the simulation. The physics simulator analyzes multi-body dynamics and contact dynamics to accurately compute physical interactions. The aforementioned simulators exchange necessary information via the data flow manager, effectively interpreting the satellite's orbit and attitude states. As a use case of AstroROS, a mission operation simulation of a satellite equipped with a robotic arm and an attitude control system was performed. The results of this analysis are anticipated to be utilized in future ADR mission analyses.



Keywords : On-Orbit Servicing(OOS), Orbital Mechanics, Open-source, Robot Operating System(ROS), Gazebo, Software-in-the-Loop-Simulation, Active Debris Removal(ADR)

Acknowledgments

This research was supported by the National Research Foundation of Korea (NRF) grant funded by the Ministry of Science and ICT.
(No. NRF-2022ew2M1A3B8073175)