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DEVELOPMENT OF GUIDANCE, NAVIGATION, AND CONTROL STRATEGY FOR THE AUTOMATED DOCKING OPERATION ON HTV-X

Abstract

Japan Aerospace Exploration Agency (JAXA) is developing the next generation unmanned rendezvous visiting vehicle "HTV-X" to provide not only the advanced cargo transportation capability for the International Space Station (ISS) but also the service as the technology tryout platform in Low Earth orbit (LEO) at the end of its mission. Exploiting its ability, JAXA plans to demonstrate the automated docking technique. The automated docking system is one of the critical technologies to realize the sustainable activity on the future cis-lunar Gateway station where the crew-based operation such as capturing the rendezvous vehicle by a real-time robotic arm operation on the space station is not available.

To achieve the automated docking successfully, requirement for the initial condition of the physical contact should be initially specified to execute both the guidance, navigation, and, control (GNC) and the mechanical docking analytical simulations. Also, as a countermeasure for the off-nominal events such as docking failure after initial contact due to the mechanical malfunction of the docking system, it is important to assess the retreat scenario from the failed condition and re-rendezvous scenario for retrying the docking.

This paper firstly presents the concept of a GNC strategy to address 6 degrees-of-freedom spacecraft attitude and position control for future HTV-X docking missions, and then rendezvous trajectory considering passive abort safety and the 3D LiDAR-based navigation are implemented. Finally, the feasibility of automated docking system is assessed through the parametric simulation results.