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REQUIREMENTS AND DESIGN STUDY OF THE HTV RECOVERY TRAJECTORY

Abstract

The H-II Transfer Vehicle (HTV) is an unmanned cargo transport and waste disposal vehicle for the International Space Station (ISS) developed by the Japan Aerospace Exploration Agency (JAXA).

The demonstration flight (HTV-1) was launched by the H-IIB launch vehicle from JAXA's Tanegashima Space Center (TNSC) on September 11, 2009. After separation from the H-IIB, the HTV continued its rendezvous flight to the ISS using its own propulsion system, which was operated by onboard flight software and ground control, without delay in the rendezvous timeline. The rendezvous flight was successfully completed on September 18, 2009, with safe and timely capture operation of the HTV by the ISS robotics arm (SSRMS).

To ensure ISS safety during the HTV flight phase, the HTV nominal and free drift trajectory, including the 3-sigma dispersion, must stay outside of the "approach ellipsoid (AE)" for a minimum of 24 hours prior to final approach initiation to the ISS. The AE is an ellipsoid of 4 km x 2 km x 2km, centered at the ISS center of mass, with the major axis along the V-bar direction. It is a requirement of the design and verification for the HTV Guidance Navigation Control (GNC) subsystem related to the trajectory.

The HTV GNC functions must meet the requirement during not only nominal flight but also recovery flight. If, for example, an unexpected delta-V happens and threatens collision with the ISS, the HTV must conduct an abort and cancel the subsequent nominal maneuvers to prevent such a hazardous situation. After that, the uploaded maneuver sequence is executed in accordance with a new rendezvous trajectory plan for the recovery flight, which is drawn up by the flight control team in such a way that it still meets the requirements.

This paper describes those relevant requirements and presents the design study results of the HTV recovery trajectory. The recovery trajectory should be designed on a case-by-case basis in the actual situation because it is highly dependent on the initial condition of the HTV even if the other constraints are fixed. Therefore, in this study, typical recovery trajectory patterns are presented. The relevant functions in the HTV GNC subsystem are presented, as well.