CTV RENDEZVOUS TECHNIQUES

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Statement of technical details of the capability being described

The cargo transfer vehicle (CTV) requires the capability to perform automated rendezvous with Space Station Freedom (SSF) using onboard sensors and algorithms. The current approach to CTV rendezvous applies techniques developed during the orbital maneuvering vehicle (OMV) program which have been mechanized for automatic, onboard execution. The initial catch up sequence can be described as a passive rendezvous without explicit time of arrival control. The ultimate requirement for this rendezvous technique is to place the CTV on the SSF V-bar axis at some specified downrange distance. The launch vehicle will use yaw steering during orbit injection to achieve the proper phantom plane for nodal biasing. This presentation describes the primary components of the CTV rendezvous scheme.

The CTV rendezvous scheme is composed of 6 primary components which are:

a. Perigee adjustment - initial injection into the phasing orbit following main engine cutoff (MECO)

b. Rendezvous phasing - phasing coast varying from a few to many tens of hours with delta-V maneuvers performed only for maintaining the J2 bias plane

c. Apsidal translation - a targeted adjustment of the phasing perigee into an intermediate phasing orbit which guarantees that perigee will occur at a required target relative phase angle after a specific number of intermediate phasing revolutions

d. Stable orbit injection - a targeted transfer from the intermediate phasing orbit perigee to the target V-bar stable orbit axis outside of the SSF proximity control zone

e. Stable orbit rendezvous - a series of targeted transfers which cause travel along the target V-bar stable orbit axis and terminates in close proximity to the target

f. Proximity operations - final, 6 degree of freedom (6DOF) closed loop control in close proximity to the target.

Each of the above rendezvous segments will be discussed and key issues and design drivers which affect the CTV functional requirements will be presented. Results from analysis and 6 DOF simulations will be given to show the characteristics of this rendezvous scheme.

History of the origins and evolution of the capability

TRW has broad experience in the area of autonomous proximity operations, autonomous docking, auto rendezvous, and 6 DOF control of maneuvering spacecraft. This experience is derived from the OMV contract and TRW IRAD programs.

The level of maturity of the capability

The capability for autonomous rendezvous and autonomous proximity operations is currently evolving and requirements are being generated and validated through extensive simulations. TRW's IRAD program is currently addressing the issues of autonomous proximity and docking technologies as well as automated rendezvous. In addition, TRW is supporting the CTV study efforts.

Test experience and/or experimental results

The automated guidance, navigation, and control algorithms have been implemented in the orbital maneuvering and servicing simulator (OMSS) at TRW. In addition, CTV configurations and mission scenarios have been generated and are being evaluated using the OMSS.

Source/sponsorship and current funding estimates

This work is currently supported by the CTV study contract.