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Performance Capabilities of a "Phase One" Automatic Rendezvous and Capture System

by

Peter M. Kachmar, Draper Laboratory
Robert J. Polutchko, Draper Laboratory
Martin Matusky, Draper Laboratory

ABSTRACT

This paper presents an analysis of the performance of the existing "Phase One" AR&C system developed at the C.S. Draper Laboratory for both the rendezvous and proximity operations mission phases. This material has been developed as a result of Draper Laboratory involvement through NASA's Johnson Space Center in the development of the flight proven IGN&C rendezvous systems for Apollo, Skylab, and Shuttle. The development of these systems using Draper computer simulations has required automation of all crew inputs to the IGN&C system and thus provided the unique opportunity to develop and test those system capabilities required for AR&C. This paper expands upon the material in the papers presented by the authors at the NASA Autonomous Rendezvous and Docking Conference held at JSC on August 15-16, 1991.

As an introduction, the IGN&C architecture of Automated Rendezvous and Capture system which has evolved out of Draper's extensive experience with manned IGN&C rendezvous systems is reviewed. Changes and additions to the current Space Shuttle IGN&C system implemented in this "Phase One" system to provide an AR&C capability are highlighted. Since this system has evolved from a manned approach to rendezvous and proximity operations, it is shown that provisions for human operators to monitor operation and a manned take-over capability are easily incorporated.

Performance data for this "Phase One" AR&C system will be presented in order to assess operations throughout the approach profile, from the initiation of the rendezvous mission phase through the proximity operations phase, to the capture condition. Figures of merit for rendezvous and proximity operations performance are identified and employed to compare the performance of the system in several rendezvous and proximity operations

The Charles Stark Draper Laboratory, Inc.
Mail Station 2B, 555 Technology Square, Cambridge, Massachusetts 02139-3563
Telephone (617) 258-1000 FAX: (617) 565-8674 /FTSS: 835-8674

scenarios. A comparison to manned system performance is established. Performance of an AR&C capable Shuttle during operations with SSF is addressed.

This performance data presented has been generated at the Draper Laboratory using linear covariance and deterministic analysis simulations of a Space Shuttle vehicle. The asymmetrical mass properties and complex set of RSC jets make the Space Shuttle an excellent example of a highly coupled "generic" spacecraft. Under contract to NASA Johnson, these simulations have been used to support flight techniques development, to define performance bounds for flight rules, to assess system performance and capability, to provide signature data for flight software verification, and to conduct detailed post-flight analyses.

Planned enhancements to this "Phase One" system, and additional capabilities required by a flight ready AR&C system are outlined in terms of a phased approach to AR&C capability development.

Authors:

Peter M. Kachmar
IGN&C Systems Section Head, C.S.Draper Laboratory
555 Technology Square Cambridge, MA. 02139
Phone: 617-258-2431 FAX: 617-565-8674

Robert J. Polutchko
IGN&C Systems Technical Staff, C.S.Draper Laboratory
555 Technology Square Cambridge, MA. 02139
Phone: 617-258-3177 FAX: 617-565-8674

Martin M. Matusky
IGN&C Systems Technical Staff, C.S.Draper Laboratory
555 Technology Square Cambridge, MA. 02139
Phone: 617-258-2440 FAX: 617-565-8674