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Automatic Rendezvous and Capture System Development in an Manned Environment

by

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ABSTRACT

This paper presents the development of a "Phase One" AR&C system capability as a logical outgrowth of Rendezvous and Proximity Operations (R&PO) system development for manned space programs. The continuity of the approach to R&PO across the Apollo, Skylab, Apollo-Soyuz, and Shuttle programs is traced and lessons learned which are applicable to AR&C discussed. Use of the Shuttle as a test bed for Automatic Rendezvous and Capture capabilities and technology demonstrations is discussed. A status of the current Phase One System design and brief overview of its capabilities is presented.

Draper Laboratory (formerly the M.I.T. Instrumentation Laboratory), designed the Apollo IGN&C rendezvous system and, with NASA Johnson Space Center, developed the operational procedures and final rendezvous profile for the Apollo missions. The Apollo system was initially developed as an automatic system. Modifications were subsequently made to provide the flexible manned operational capability successfully demonstrated throughout the program. Following Apollo, Draper has had a principal role with JSC in the development of IGN&C rendezvous systems for the major U.S. space programs.

IGN&C rendezvous system development from Gemini, Apollo, Skylab and Shuttle has provided the unique opportunity to design and evaluate most of the component systems of a complete automatic rendezvous and capture system. On-orbit operational experience with these integrated systems during actual rendezvous and proximity operations has provided an opportunity to demonstrate rendezvous and proximity operations capabilities and validate the design methodologies employed.

Development and testing of flight proven IGN&C systems using computer simulation has required the development of a rule-based expert system to perform the manual system operations as well as the development of an automated (digital) pilot to perform the trajectory control functions during proximity operations. These development

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applications have matured to a level that, coupled with the proven designs of the IGN&C flight systems themselves, provide the requisite capabilities of a "Phase One" AR&C system.

Since this Phase One AR&C system was initially developed to simulate manned rendezvous and proximity operations, as an automated system it may be easily monitored by human operators and can be implemented with the capability of manned takeover should the need arise.

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