AUTOMATIC RENDEZVOUS SYSTEM TESTING AT THE FLIGHT ROBOTICS LABORATORY

Patrick A. Tobbe : Control Dynamics Co. (205) 882 - 2650
Fax (205) 882 - 2683

Charles B. Naumann : Control Dynamics Co.

The Flight Robotics Laboratory of the Marshall Space Flight Center provides sophisticated real time simulation capability in the study of human/system interactions of remote systems. The facility consists of a four thousand square foot precision air bearing floor, a teleoperated motion base, a dynamic overhead target simulator, a remote operator's work station, and various simulation mock ups. This paper will describe the use of the overhead manipulator to study the performance of two automatic rendezvous systems in a real time hardware-in-the-loop simulation. The candidate systems were to be used with the Orbital Maneuvering Vehicle and a servicing satellite for the Polar Platform.

The Dynamic Overhead Target Simulator (DOTS) is an eight degree of freedom, heavy duty electric manipulator capable of traversing over the entire air bearing floor. The system is composed of a precision overhead X-Y crane to which a six degree of freedom robot arm is mounted. A VAX computer is used in real time to convert arm tip position and orientation commands into crane position and arm joint velocity commands. These commands are generated through inverse kinematic relationships and digital control laws housed on the VAX. An elaborate real time safety algorithm is also driven by the VAX to perform collision avoidance and joint position and rate limiting.

In the facility, a mock up of the chase vehicle was placed on the arm tip of the DOTS and a target vehicle mock up was fixed at a location on the edge of the air bearing surface. Both automatic rendezvous approaches used a camera system to generate relative range and orientation data between the vehicles which were interfaced to the real time computer system. For the Polar Platform servicing vehicle, a camera system and infrared LED targets were attached to the mock ups. The OMV system made use of a camera system with infrared laser diodes and passive target reflectors.

The control system for the DOTS and a real time dynamic simulation of the mating vehicles are both on the VAX computer network. The simulation models two rigid vehicles in orbit which may undergo large translations and rotations. The vehicles are acted on by gravitational effects and control system actuators and thrusters. The output of the range/rate sensor is used by the automatic rendezvous algorithm to compute vehicle control system commands, which act as forcing functions in the equations of motion. The equations of motion are solved numerically for the resulting relative position and orientation between the vehicle interface points. This data is then used to compute manipulator tip position and orientation commands such that the resulting motion between the mock ups matches that of the numerical simulation.

This paper will describe the Flight Robotics Facility of NASA/MSFC, the hardware-in-the-loop simulation configuration, and test results.

Control Dynamics has been sponsored in this effort in part by MSFC EB24 under contract NAS8 - 36570.