

## A Synthetic Environment for Visualization and Planning of Orbital Maneuvers

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### Abstract:

An interactive proximity operations planning system, which allows on-site planning of fuel-efficient, multi-burn maneuvers in a potential multi-space-craft environment has been developed and tested. This display system most directly assists planning by providing visual feedback in a synthetic virtual space that aids visualization of trajectories and their constraints. Its most significant features include 1) an "inverse dynamics" algorithm that removes control nonlinearities facing the operator and 2) a stack-oriented action-editor that reduces the order of control and creates, through a "geometric spreadsheet," the illusion of an inertially stable environment. This synthetic environment provides the user with control of relevant static and dynamic properties of waypoints during small orbital changes allowing independent solutions to otherwise coupled problems of orbital maneuvering.

The display provides a format for conveniently visualizing, creating or editing multiburn orbital maneuvers. An experiment has been carried out in which briefly trained operators were required to plan a trajectory to retrieve an object accidentally

separated from a dual-keel space station. The time required to plan these maneuvers was found to be predicted by the direction of the insertion thrust and did not depend on the point of separation from the space station. Analysis of the operators' performance also indicates that while they are able to quickly plan feasible solutions to complex orbital problems, optimal solutions for multiburn maneuvers will require additional display enhancements. Current work is directed to developing these new symbolic enhancements as well as improving the human interface to the display. Formal papers in archival journals of test results have been accepted for publication and should appear in mid 1992..

Versions of the display software have been distributed to a number of industrial and government laboratories within the U.S. and abroad. This project has developed from previous work on visualization tools for air traffic and has been funded by OAET R&D and Space Exploration Initiative funds. Cuts in '92 SEI budget for human factors may jeopardize the future of this research and development. Funding requirements are

approximately \$70K/year for 1 - 2 years to complete work in progress.

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