Design of the Remote Agent Experiment for Spacecraft Autonomy

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ABSTRACT

Spacecraft designers are drawn to the idea of increasing the level of flight system autonomy for a number of reasons. These include ensuring robust operation after faults, taking advantage of science opportunities made possible by faster decision making, and reduction in spacecraft operations costs.

Mission controllers are also interested in increased autonomy, but bring a number of concerns and requirements to the discussion. Mission controllers need to know that they will be able to control the spacecraft if things go wrong. They would prefer to demonstrate new capabilities first on the ground and then migrate those capabilities to spacecraft, and they need to be able to predict (at some level) how the spacecraft will behave.

This paper describes a remote agent approach to spacecraft autonomy that shows promise for meeting the autonomous system aspirations of the spacecraft designers while also meeting the needs of the mission controllers. The basic concept is that mission controllers can communicate at a high level of abstraction to an agent that is remotely located on the spacecraft. This remote agent understands the abstract goals and creates and executes robust plans to carry them out.

The remote agent is formed by the integration of three separate technologies: an on-board planner-scheduler, a robust multi-threaded executive, and a model-based fault diagnosis and recovery system.

Among the autonomy capabilities to be demonstrated on the Deep Space One remote agent are: achieving goal oriented on-board planning, replanning after failures given the new context, demonstrating both time- and event-driven execution, demonstrating context-sensitive task decomposition, demonstrating model-based failure detection and recovery, and demonstrating call-home behavior in severe situations.

This remote agent approach is being designed into the New Millennium Program's Deep Space One mission as an experiment. The experiment is slated to be exercised in October of 1998.