

Abstract

The first mission of NASA's New Millennium Program, *Deep Space 1*, has, as one of its principal demonstration-technologies, the first autonomous optical navigation system to be used in deep space. The concept of *DS1*, to develop and validate new technologies in the context of a low-cost deep space planetary mission, was an extremely challenging one. In practice the challenges were even greater. Nevertheless, the complete manifest of technologies was validated, with most of them proving highly successful, including the autonomous navigation system, AutoNav.

The theoretical basis of AutoNav is a process in which images of asteroids (typically main-belt) are taken against the distant stars, and through the measured parallax, geometric information is inferred. This information is used in a dynamic filter to determine the spacecraft position and velocity, as well as parameters describing the performance of the ion engine (IPS) and solar pressure. With this information, corrections to the mission design as described in the propulsion profile are made and/or predictions for necessary trajectory correction maneuvers

(TCMs) are computed. This system is shown diagrammatically in the "Fact Sheet" Figure 1.

The AutoNav system is a set of software elements that interact with the imaging, attitude control and ion-propulsion systems aboard *DS1*. The principal elements and functions of AutoNav are: 1) NavRT, which provides critical ephemeris information to other onboard subsystems, such as the Attitude Control System, 2) NavExec, which plans and executes various important Nav related activities, such as image-taking and processing, Ion Propulsion System thrusting events, and TCMs, 3) ImageProcessor: the image processing subsystem, 4) OD: the orbit determination computation element, 5) ManeuverPlanner: which performs computations relative to the IPS events and the TCMs.

The Validation of the AutoNav system was to be accomplished through its use as the principal navigation system. As such, a comprehensive series of activities were planned to primarily accomplish the many navigation tasks for *DS1*, and secondarily to validate AutoNav. These tasks and their completion and/or validation status are shown in the "Fact Sheet" Table 1.

Figure 1: Fact Sheet Figure - Diagrammatic and Comparative Description of AutoNav Technology and Validation

