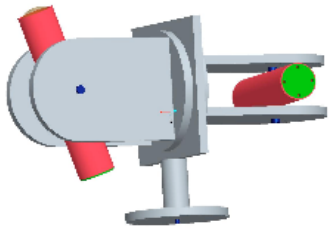
Spacecraft Control Toolbox Version 7.0

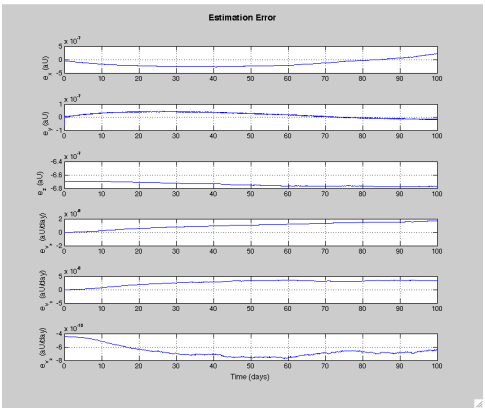
Deep Space Navigation Sensor

Princeton Satellite Systems was awarded a NASA Phase II SBIR on October 11, 2007, to develop the "Optical Navigation System." This is a new sensor for deep space autonomous navigation. The goal is to develop a sensor that does not require Global Positioning System data or measurements taken by the NASA Deep Space Network. The sensor will be fully integrated and standalone only requiring attitude information from the spacecraft attitude determination system. The sensor employs an Unscented Kalman Filter for orbit determination and also has a background batch estimator. The filter can also be used to identify selected parameters in the system during operation. The filter uses nonlinear dynamical and measurement models directly without the need for linearization of either the measurement or dynamical models. Integration of the dynamical model and covariance is done numerically.

The following figure shows a conceptual design of the navigation sensor. It consists of two double gimbaled telescopes mounted on a rotating base. The telescopes can point at any celestial target, such as the sun, planets or starts, to get navigation fixes. The sensor was developed by Prof. Michael Littman of Princeton University under a subcontract from Princeton Satellite Systems. The second figure shows a simulation of the Unscented Kalman Filter used to estimate the position and velocity. The plots show the position and velocity error during a deep space mission.

The sensor employs full n-body gravity model using the most up-to-date ephemerides along with a solar pressure model. The software was tested and validated in Matlab using the Spacecraft Control Toolbox before being ported to C++ for used in the flight software. The estimator used the existing Unscented Kalman Filter algorithms in the Spacecraft Control Toolbox which have been used for many other applications. The simulation models in the toolbox included the JPL Ephemerides of the major planets plus a solar pressure model for a solar sail. One of the trajectories tested was for a solar sail on a heliopause mission in which it passes near the sun before heading out of the solar system at high speed.





The Spacecraft Control Toolbox facilitated the development of the supporting software and permitted extensive studies to be done within the budget of a NASA SBIR contract. This reduced the amount of testing required for the C++ software. Only tests validating it against the software in the toolbox were required. All of the dynamical models and estimator software used in this program are available as part of the toolbox along with numerous illustrative examples.

Upgrading to Version 7.0

If you have purchased or upgraded the Spacecraft Control Toolbox within the last year, you will receive this release for free. Prior customers should contact us for their upgrade price.

For More Information

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