Software

Software Modules for the Proximity-1 Space Link Interleaved Time Synchronization (PITS) Protocol

The Proximity-1 Space Link Interleaved Time Synchronization (PITS) protocol provides time distribution and synchronization services for space systems. A software prototype implementation of the PITS algorithm has been developed that also provides the test harness to evaluate the key functionalities of PITS with simulated data source and sink.

PITS integrates time synchronization functionality into the link layer of the CCSDS Proximity-1 Space Link Protocol. The software prototype implements the network packet format, data structures, and transmit- and receive-timestamp function for a time server and a client. The software also simulates the transmit- and receive-time stamp exchanges via UDP (User Datagram Protocol) socket between a time server and a time client, and produces relative time offsets and delay estimates.

This work was done by Simon S. Woo, John R. Veregge, Jay L. Gao, and Loren P. Clare of Caltech; and David Mills of the University of Delaware for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47404.

Description and User Instructions for the Quaternion_to_orbit_v3 Software

For a given inertial frame of reference, the software combines the spacecraft orbits with the spacecraft attitude quaternions, and rotates the body-fixed reference frame of a particular spacecraft to the inertial reference frame. The conversion assumes that the two spacecraft are aligned with respect to the mutual line of sight, with a parameterized time tag. The software is implemented in Python and is completely open source. It is very versatile, and may be applied under various circumstances and for other related purposes. Based on the solid linear algebra analysis, it has an extra option for compensating the linear pitch.

This software has been designed for simulation of the calibration maneuvers performed by the two spacecraft comprising the GRAIL mission to the Moon, but has potential use for other applications. In simulations of formation flights, one needs to coordinate the spacecraft orbits represented in an appropriate inertial reference frame and the spacecraft attitudes. The latter are usually given as the time series of quaternions rotating the body-fixed reference frame of a particular spacecraft to the inertial reference frame. It is often desirable to simulate the same maneuver for different segments of the orbit. It is also useful to study various maneuvers that could be performed at the same orbit segment. These two lines of study are more time- and labor-efficient if the attitude and orbit data are generated independently, so that the part of the data that has not been changed can be "recycled" in the course of multiple simulations.

This work was done by Dmitry V. Strekalov, Gerhard L. Kruizinga, Meegyeong Paik, Dah-Ning Yuan, and Sami W. Asmar of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47701.

AdapChem

AdapChem software enables high efficiency, low computational cost, and enhanced accuracy on computational fluid dynamics (CFD) numerical simulations used for combustion studies. The software dynamically allocates smaller, reduced chemical models instead of the larger, full chemistry models to evolve the calculation while ensuring the same accuracy to be obtained for steady-state CFD reacting flow simulations.

The software enables detailed chemical kinetic modeling in combustion CFD simulations. AdapChem adapts the reaction mechanism used in the CFD to the local reaction conditions. Instead of a single, comprehensive reaction mechanism throughout the computation, a dynamic distribution of smaller, reduced models is used to capture accurately the chemical kinetics at a fraction of the cost of the traditional "single-mechanism" approach.

This work was done by Oluwayemisi O. Oluwole and Hsi-Wu Wong of Aerodyne Research Inc., and William Green of MIT for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18786-1.

Mars Relay Lander and Orbiter Overflight Profile Estimation

This software allows science and mission operations to view graphs of geometric overflights of satellites and landers within the Mars (or other planetary) networks. It improves on the MaROS Web interface within any modern Web browser, in that it adds new capabilities to the MaROS suite.

The profile for an overflight is an important element for selecting communication/overflight opportunities between the landers and orbiters within the Mars network. Unfortunately, determining these estimates is very computationally expensive and difficult to compute by hand. This software allows the user to select different overflights (via the existing MaROS Web interface) and specify the smoothness of the estimation.

Estimates for the geometric relationship between a lander and an orbiter are determined based upon the orbital conditions of the orbiter at the moment the orbiter rises above the horizon from the perspective of the lander. It utilizes 2-body orbital equations to propagate the trajectory through the duration of the view period, and returns profiles that represent the range between the two vehicles, and the elevation and azimuth angles of the orbiter as measured from the lander's position. The algorithms assume a 2-body relationship with an ideal, spherical planetary body, so therefore can see errors less than 2% at polar landing sites on Mars. These algorithms are being implemented to provide rough estimates rapidly for the geometry of a geometric view period where more complete data is unavailable, such as for