Software

MIRO Computational Model

A computational model calculates the excitation of water rotational levels and emission-line spectra in a cometary coma with applications for the Microwave Instrument for Rosetta Orbiter (MIRO). MIRO is a millimeter-submillimeter spectrometer that will be used to study the nature of cometary nuclei, the physical processes of outgassing, and the formation of the head region of a comet (coma). The computational model is a means to interpret the data measured by MIRO.

The model is based on the accelerated Monte Carlo method, which performs a random angular, spatial, and frequency sampling of the radiation field to calculate the local average intensity of the field. With the model, the water rotational level populations in the cometary coma and the line profiles for the emission from the water molecules as a function of cometary parameters (such as outgassing rate, gas temperature, and gas and electron density) and observation parameters (such as distance to the comet and beam width) are calculated.

This work was done by Paul A. Von Allmen and Seungwon Lee 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-46508.

Team Collaboration Software

The Ground Resource Allocation and Planning Environment (GRAPE 1.0) is a Web-based, collaborative team environment based on the Microsoft SharePoint platform, which provides Deep Space Network (DSN) resource planners' tools and services for sharing information and performing analysis. The foundation platform for GRAPE provides a number of communication and data-management mechanisms, which help planners communicate scheduling issues, including document management, security schemes, calendars, wikis, blogs, lists, issue tracking, discussion forums, workflow management, alerts/notifications, and configuration management.

Additionally, a set of "web parts" has been developed for DSN resource-allocation-specific analysis, including tools for managing ground asset and mission information; finding configuration codes; displaying, querying, and comparing schedules; analyzing mission coverage; checking for schedule conflicts; creating and submitting schedule change requests; and viewing and validating mission view periods. The methodology of web parts allows individual users to compose their own Web pages by picking the web parts they want to use on a Web page, rather than developers designing Web pages for users. This allows developers to focus more on functionality and less on appearance and integration, while users are empowered to compose Web pages for their immediate analysis and collaboration needs rather than waiting for another long development cycle for some new capability. GRAPE web parts, which connect to existing DSN middle-tier Web services for many computation and data access activities, support Service Oriented Architecture (SOA), and component-style development.

This work was done by Yeou-Fang Wang, Mitchell Schrock, John R. Baldwin, and Chester S. Borden 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-45988.

Comet Gas and Dust Dynamics Modeling

This software models the gas and dust dynamics of comet coma (the head region of a comet) in order to support the Microwave Instrument for Rosetta Orbiter (MIRO) project. MIRO will study the evolution of the comet 67P/Churyumov-Gerasimenko's coma system. The instrument will measure surface temperature, gas-production rates and relative abundances, and velocity and excitation temperatures of each species along with their spatial temporal variability. This software will use these measurements to improve the understanding of coma dynamics.

The modeling tool solves the equation of motion of a dust particle, the energy balance equation of the dust particle, the continuity equation for the dust and gas flow, and the dust and gas mixture energy equation. By solving these equations numerically, the software calculates the temperature and velocity of gas and dust as a function of time for a given initial gas and dust production rate, and a dust characteristic parameter that measures the ability of a dust particle to adjust its velocity to the local gas velocity.

The software is written in a modular manner, thereby allowing the addition of more dynamics equations as needed. All of the numerical algorithms are added in-house and no third-party libraries are used.

This work was done by Paul A. Von Allmen and Seungwon Lee 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-46507.

Online Planning Algorithm

AVA v2 software selects goals for execution from a set of goals that oversubscribe shared resources. The term "goal" refers to a science or engineering request to execute a possibly complex command sequence, such as image targets or ground-station downlinks.

Developed as an extension to the Virtual Machine Language (VML) execution system, the software enables onboard and remote goal triggering through the use of an embedded, dynamic goal set that can oversubscribe resources. From the set of conflicting goals, a subset must be chosen that maximizes a given quality metric, which in this case is strict priority selection. A goal can never be preempted by a lower priority goal, and high-level goals can be added, removed, or updated at any time, and the "best" goals will be selected for execution.

The software addresses the issue of re-planning that must be performed in a short time frame by the embedded system where computational resources are constrained. In particular, the algorithm addresses problems with well-defined goal requests without temporal flexibility that oversubscribes available resources. By using a fast, incremental algorithm, goal selection can be postponed in a "just-in-time" fashion allowing requests to be changed or added at the last minute. Thereby enabling shorter response times and greater autonomy for the system under control.

This work was done by Gregg R. Rabideau and Steve A. Chien of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-46503.

AutoGNC Testbed

A simulation testbed architecture was developed and implemented for the integration, test, and development of a TRL-6 flight software set called AutoGNC. The AutoGNC software will combine the TRL-9 Deep Impact AutoNAV flight software suite, the TRL-9 Virtual Machine Language (VML) executive, and the TRL-3 G-REX guidance, estimation, and control algorithms. The AutoGNC testbed was architected to provide software interface connections among the AutoNAV and VML flight code written in C, the G-REX algorithms in MATLAB and C, stand-alone image rendering algorithms in C, and other Fortran algorithms, such as the OBIRON landmark tracking suite.

The testbed architecture incorporates software components for propagating a high-fidelity "truth" model of the environment and the spacecraft dynamics, along with the flight software components for onboard guidance, navigation, and control (GN&C). The interface allows for the rapid integration and testing of new algorithms prior to development of the C code for implementation in flight software.

This testbed is designed to test autonomous spacecraft proximity operations around small celestial bodies, moons, or other spacecraft. The software is baselined for upcoming comet and asteroid sample return missions. This architecture and testbed will provide a direct improvement upon the onboard flight software utilized for missions such as Deep Impact, Stardust, and Deep Space 1.

This work was done by John M. Carson III, Andrew T. Vaughan, David S. Bayard, Joseph E. Riedel, and J. Balaram of Caltech for NASA's Jet Propulsion Laboratory.

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO 46557.

Optical Imaging and Radiometric Modeling and Simulation

OPTOOL software is a general-purpose optical systems analysis tool that was developed to offer a solution to problems associated with computational programs written for the James Webb Space Telescope optical system. It integrates existing routines into coherent processes, and provides a structure with reusable capabilities that allow additional processes to be quickly developed and integrated. It has an extensive graphical user interface, which makes the tool more intuitive and friendly.

OPTOOL is implemented using MATLAB with a Fourier optics-based approach for point spread function (PSF) calculations. It features parametric and Monte Carlo simulation capabilities, and uses a direct integration calculation to permit high spatial sampling of the PSF. Exit pupil optical path difference (OPD) maps can be generated using combinations of Zernike polynomials or shaped power spectral densities. The graphical user interface allows rapid creation of arbitrary pupil geometries, and entry of all other modeling parameters to support basic imaging and radiometric analyses.

OPTOOL provides the capability to generate wavefront-error (WFE) maps for arbitrary grid sizes. These maps are 2D arrays containing digital sampled versions of functions ranging from Zernike polynomials to combination of sinusoidal wave functions in 2D, to functions generated from a spatial frequency power spectral distribution (PSD). It also can generate optical transfer functions (OTFs), which are incorporated into the PSF calculation.

The user can specify radiometrics for the target and sky background, and key performance parameters for the instrument's focal plane array (FPA). This radiometric and detector model setup is fairly extensive, and includes parameters such as zodiacal background, thermal emission noise, read noise, and dark current. The setup also includes target spectral energy distribution as a function of wavelength for polychromatic sources, detector pixel size, and the FPA's charge diffusion modulation transfer function (MTF).

This work was done by Kong Q. Ha of KDA Engineering; Michael W. Fitzmaurice of Swales Aerospace; and Gary E. Moiser, Joseph M. Howard, and Chi M. Le of Goddard Space Flight Center. Further information is contained in a TSP (see page 1).GSC-15720-1