Software

SHINE Virtual Machine Model for In-flight Updates of Critical Mission Software

This software is a new target for the Spacecraft Health Inference Engine (SHINE) knowledge base that compiles a knowledge base to a language called Tiny C — an interpreted version of C that can be embedded on flight processors. This new target allows portions of a running SHINE knowledge base to be updated on a "live" system without needing to halt and restart the containing SHINE application. This enhancement will directly provide this capability without the risk of software validation problems and can also enable complete integration of BEAM and SHINE into a single application.

This innovation enables SHINE deployment in domains where autonomy is used during flight-critical applications that require updates. This capability eliminates the need for halting the application and performing potentially serious total system uploads before resuming the application with the loss of system integrity. This software enables additional applications at JPL (microsensors, embedded mission hardware) and increases the marketability of these applications outside of JPL.

This work was done by Mark James, Ryan Mackey, and Raffi Tikidjian of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-44547, volume and number of this NASA Tech Briefs issue, and the page number.

Mars Image Collection Mosaic Builder

A computer program assembles images from the Mars Global Surveyor (MGS) Mars Observer Camera Narrow Angle (MOCNA) collection to generate a uniform-high-resolution, georeferenced, uncontrolled mosaic image of the Martian surface. At the time of reporting the information for this article, the mosaic covered 7 percent of the Martian surface and contained data from more than 50,000 source images acquired under various light conditions at various resolutions.

The program geolocates, reprojects, and blends one source image at a time onto the mosaic. Geolocation and reprojection involve the use of a second-order polynomial based on coordinates of the source-image footprints. Images are stacked in the order of increasing resolution — higher-resolution images on top of lower-resolution images. The stacking order is also partly determined by the order of adding the source images to the mosaic. The mosaic-image data are stored in a custom file format that accommodates regional tiles and supports explicit representation of empty areas, image-data compression, and representation of localized changes.

The program is written as a script in the ImageTCL software of Silicon Graphics, Inc. (SGI), using SGI Image Vision Library with extensions specific to a geographic information system.

This program was written by Lucian Plesea of Caltech and Trent Hare of the United States Geological Survey for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45960.

Providing Internet Access to High-Resolution Mars Images

The OnMars server is a computer program that provides Internet access to high-resolution Mars images, maps, and elevation data, all suitable for use in geographical information system (GIS) software for generating images, maps, and computational models of Mars. The OnMars server is an implementation of the Open Geospatial Consortium (OGC) Web Map Service (WMS) server. Unlike other Mars Internet map servers that provide Martian data using an Earth coordinate system, the OnMars WMS server supports encoding of data in Mars-specific coordinate systems.

The OnMars server offers access to most of the available high-resolution Martian image and elevation data, including an 8-meter-per-pixel uncontrolled mosaic of most of the Mars Global Surveyor (MGS) Mars Observer Camera Narrow Angle (MOCNA) image collection, which is not available elsewhere. This server can generate image and map files in the tagged image file format (TIFF), Joint Photographic Experts Group (JPEG), 8- or 16-bit Portable Network Graphics (PNG), or Keyhole Markup Language (KML) format. Image control is provided by use of the OGC Style Layer Descriptor (SLD) protocol. The OnMars server also implements tiled WMS protocol and super-overlay KML for high-performance client application programs.

This program was written by Lucian Plesea of Caltech and Trent Hare of the United States Geological Survey for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45959.

Providing Internet Access to High-Resolution Lunar Images

The OnMoon server is a computer program that provides Internet access to high-resolution Lunar images, maps, and elevation data, all suitable for use in geographical information system (GIS) software for generating images, maps, and computational models of the Moon. The OnMoon server implements the Open Geospatial Consortium (OGC) Web Map Service (WMS) server protocol and supports Moon-specific extensions. Unlike other Internet map servers that provide Lunar data using an Earth coordinate system, the OnMoon server supports encoding of data in Moon-specific coordinate systems.

The OnMoon server offers access to most of the available high-resolution Lunar image and elevation data. This server can generate image and map files in the tagged image file format (TIFF) or the Joint Photographic Experts Group (JPEG), 8- or 16-bit Portable Network Graphics (PNG), or Keyhole Markup Language (KML) format. Image control is provided

by use of the OGC Style Layer Descriptor (SLD) protocol. Full-precision spectral arithmetic processing is also available, by use of a custom SLD extension. This server can dynamically add shaded relief based on the Lunar elevation to any image layer. This server also implements tiled WMS protocol and super-overlay KML for high-performance client application programs.

This program was written by Lucian Plesea of Caltech and Trent Hare of the United States Geological Survey for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45951.

Expressions Module for the Satellite Orbit Analysis Program

The Expressions Module is a software module that has been incorporated into the Satellite Orbit Analysis Program (SOAP). The module includes an expressions-parser submodule built on top of an analytical system, enabling the user to define logical and numerical variables and constants. The variables can capture output from SOAP orbital-prediction and geometric-engine computations. The module can combine variables and constants with built-in logical operators (such as Boolean AND, OR, and NOT), relational operators (such as >, <, or =), and mathematical operators (such as addition, subtraction, multiplication, division, modulus, exponentiation, differentiation, and integration). Parentheses can be used to specify precedence of operations.

The module contains a library of mathematical functions and operations, including logarithms, trigonometric functions, Bessel functions, minimum/maximum operations, and floating-point-to-integer conversions. The module supports combinations of time, distance, and angular units and has a dimensional-analysis component that checks for correct usage of units. A parser based on the Flex language and the Bison program looks for and indicates errors in syntax. SOAP expressions can be built using other expressions as arguments, thus enabling the user to build analytical trees. A graphical user interface facilitates use.

This program was developed by Robert Carnright, David Stodden, Jim Paget, and John Coggi of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45052.

Virtual Satellite

Virtual Satellite (VirtualSat) is a computer program that creates an environment that facilitates the development, verification, and validation of flight software for a single spacecraft or for multiple spacecraft flying in formation. In this environment, enhanced functionality and autonomy of navigation, guidance, and control systems of a spacecraft are provided by a virtual satellite — that is, a computational model that simulates the dynamic behavior of the spacecraft.

Within this environment, it is possible to execute any associated software, the development of which could benefit from knowledge of, and possible interaction (typically, exchange of data) with, the virtual satellite. Examples of associated software include programs for simulating spacecraft power and thermal-management systems. This environment is independent of the flight hardware that will eventually host the flight software, making it possible to develop the software simultaneously with, or even before, the hardware is delivered. Optionally, by use of interfaces included in VirtualSat, hardware can be used instead of simulated. The flight software, coded in the C or C++ programming language, is compilable and loadable into VirtualSat without any special modifications. Thus, VirtualSat can serve as a relatively inexpensive software test-bed for development test, integration, and post-launch maintenance of spacecraft flight software.

This program was written by Stephan R. Hammers of the Hammers Co., Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14824-1

Small-Body Extensions for the Satellite Orbit Analysis Program (SOAP)

An extension to the SOAP software allows users to work with tri-axial ellipsoid-based representations of planetary bodies, primarily for working with small, natural satellites, asteroids, and comets. SOAP is a widely used tool for the visualization and analysis of space missions. The small body extension provides the same visualization and analysis constructs for use with small bodies. These constructs allow the user to characterize satellite path and instrument cover information for small bodies in both 3D display and numerical output formats.

Tri-axial ellipsoids are geometric shapes the diameters of which are different in each of three principal x, y, and z dimensions. This construct provides a better approximation than using spheres or oblate spheroids (ellipsoids comprising two common equatorial diameters as a distinct polar diameter). However, the tri-axial ellipsoid is considerably more difficult to work with from a modeling perspective. In addition, the SOAP small-body extensions allow the user to actually employ a plate model for highly irregular surfaces. Both tri-axial ellipsoids and plate models can be assigned to coordinate frames, thus allowing for the modeling of arbitrary changes to body orientation.

A variety of features have been extended to support tri-axial ellipsoids, including the computation and display of the spacecraft sub-orbital point, ground trace, instrument footprints, and swathes. Displays of 3D instrument volumes can be shown interacting with the ellipsoids. Longitude/latitude grids, contour plots, and texture maps can be displayed on the ellipsoids using a variety of projections. The distance along an arbitrary line of sight can be computed between the spacecraft and the ellipsoid, and the coordinates of that intersection can be plotted as a function of time. The small-body extension supports the same visual and analytical constructs that are supported for spheres and oblate spheroids in SOAP making the implementation of the more complex algorithms largely transparent to the user.

This work was done by Robert Carnright of Caltech and David Stodden and John Coggi of The Aerospace Corporation for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45054.

Scripting Module for the Satellite Orbit Analysis Program (SOAP)

This add-on module to the SOAP software can perform changes to simulation objects based on the occurrence of specific conditions. This allows the software to encompass simulation response of