Mission Simulation Toolkit

Ames Research Center, Moffett Field, California

The Mission Simulation Toolkit (MST) is a flexible software system for autonomy research. It was developed as part of the Mission Simulation Facility (MSF) project that was started in 2001 to facilitate the development of autonomous planetary robotic missions. Autonomy is a key enabling factor for robotic exploration. There has been a large gap between autonomy software (at the research level), and software that is ready for insertion into near-term space missions. The MST bridges this gap by providing a simulation framework and a suite of tools for supporting research and maturation of autonomy.

MST uses a distributed framework based on the High Level Architecture (HLA) standard. A key feature of the MST framework is the ability to plug in new models to replace existing ones with the same services. This enables significant simulation flexibility, particularly the mixing and control of fidelity level. In addition, the MST provides automatic code generation from robot interfaces defined with the Unified Modeling Language (UML), methods for maintaining synchronization across distributed simulation systems, XML-based robot description, and an environment server. Finally, the MSF supports a number of third-party products including dynamic models and terrain databases. Although the communication objects and some of the simulation components that are provided with this toolkit are specifically designed for terrestrial surface rovers, the MST can be applied to any other domain, such as aerial, aquatic, or space.

This project was developed by Gregory Pisanich, Lorenzo Flueckiger, Christian Neukom, Mike Wagner, Eric Buchanan, and Laura Plice of QSS Group, Inc. for Ames Research Center. For further information, access http://opensource.arc.nasa.gov/ or contact the Ames Technology Partnerships Division at (650) 604-2954. ARC-14932-1.

Solving Equations of Multibody Dynamics

NASA's Jet Propulsion Laboratory, Pasadena, California

Darts++ is a computer program for solving the equations of motion of a multibody system or of a multibody model of a dynamic system. It is intended especially for use in dynamical simulations performed in designing and analyzing, and developing software for the control of, complex mechanical systems. Darts++ is based on the Spatial-Operator-Algebra formulation for multibody dynamics. This software reads a description of a multibody system from a model data file, then constructs and implements an efficient algorithm that solves the dynamical equations of the system. The efficiency and, hence, the computational speed is sufficient to make Darts++ suitable for use in real-time closed-loop simulations. Darts++ features an object-oriented software architecture that enables reconfiguration of system topology at run time; in contrast, in related prior software, system topology is fixed during initialization. Darts++ provides an interface to scripting languages, including Tcl and Python, that enable the user to configure and interact with simulation objects at run time.

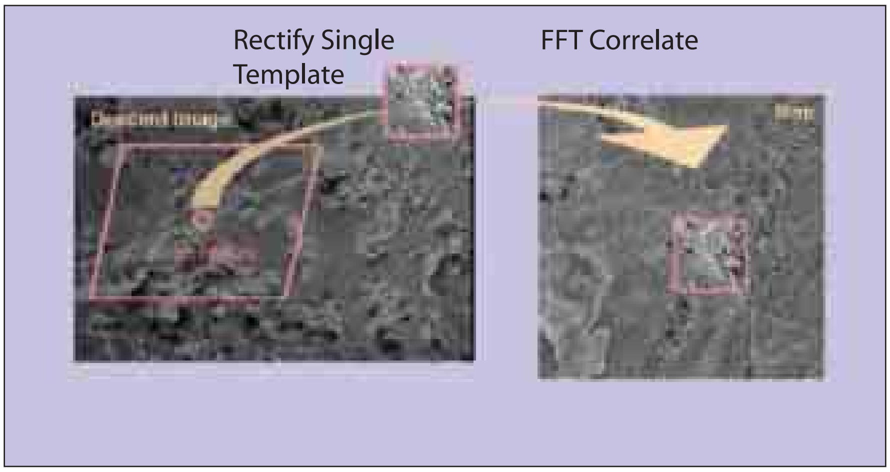
This program was written by Abhinandan Jain and Christopher Lim of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42890.

Mapped Landmark Algorithm for Precision Landing

NASA's Jet Propulsion Laboratory, Pasadena, California

A report discusses a computer vision algorithm for position estimation to enable precision landing during planetary descent. The Descent Image Motion Estimation System for the Mars Exploration Rovers has been used as a starting point for creating code for precision, terrain-relative navigation during planetary landing. The algorithm is designed to be general because it handles images taken at different scales and resolutions relative to the map, and can produce mapped landmark matches for any planetary terrain of sufficient texture. These matches provide a measurement of horizontal position relative to a known landing site specified on the surface map. Multiple



FFT Map-Matching Concept.

mapped landmarks generated per image allow for automatic detection and elimination of bad matches. Attitude and position can be generated from each image; this image-based attitude measurement can be used by the onboard navigation filter to improve the attitude estimate, which will improve the position estimates.

The algorithm uses normalized correlation of grayscale images, producing precise, sub-pixel images. The algorithm has been broken into two sub-algorithms: (1) FFT Map Matching (see figure), which matches a single large template by correlation in the frequency domain, and (2) Mapped Landmark Refinement, which matches many small templates by correlation in the spatial domain. Each relies on feature selection, the homography transform, and 3D image correlation. The algorithm is implemented in C++ and is rated at Technology Readiness Level (TRL) 4.

This work was done by Andrew Johnson, Adnan Ansar, and Larry Matthies of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-44463.

WMAP C&DH Software

Goddard Space Flight Center, Greenbelt, Maryland

The command-and-data-handling (C&DH) software of the Wilkinson Microwave Anisotropy Probe (WMAP) spacecraft functions as the sole interface between (1) the spacecraft and its instrument subsystem and (2) ground operations equipment. This software includes a command-decoding and -distribution system, a telemetry/data-handling system, and a data-storage-and-playback system. This software performs onboard processing of attitude sensor data and generates commands for attitude-control actuators in a closed-loop fashion. It also processes stored commands and monitors health and safety functions for the spacecraft and its instrument subsystems. The basic functionality of this software is the same of that of the older C&DH software of the Rossi X-Ray Timing Explorer (RXTE) spacecraft, the main difference being the addition of the attitude-control functionality. Previously, the C&DH and attitude-control computations were performed by different processors because a single RXTE processor did not have enough processing power. The WMAP spacecraft includes a more-powerful processor capable of performing both computations.

This program was written by Alan Cudmore, Tim Leath, Art Ferrer, Todd Miller, Mark Walters, Bruce Savadkin, and Ji-Wei Wu of Goddard Space Flight Center; Steve Slegel of Daedalian Systems Corp.; and Emory Stagmer of Litton/PRC. Further information is contained in a TSP (see page 1). GSC-14964-1

Web-Based Environment for Maintaining Legacy Software

Lyndon B. Johnson Space Center, Houston, Texas

"Advanced Tool Integration Environment" ("ATIE") is the name of both a software system and a Web-based environment created by the system for maintaining an archive of legacy software and expertise involved in developing the legacy software. ATIE can also be used in modifying legacy software and developing new software. The information that can be encapsulated in ATIE includes experts' documentation, input and output data of tests cases, source code, and compilation scripts. All of this information is available within a common environment and retained in a database for ease of access and recovery by use of powerful search engines. ATIE also accommodates the embedment of supporting software that users require for their work, and even enables access to supporting commercial-off-the-shelf (COTS) software within the flow of the experts' work.

The flow of work can be captured by saving the sequence of computer programs that the expert uses. A user gains access to ATIE via a Web browser. A modern Web-based graphical user interface promotes efficiency in the retrieval, execution, and modification of legacy code. Thus, ATIE saves time and money in the support of new and pre-existing programs.

This program was written by Michael Tigges of Johnson Space Center; Nelson Thompson, Mark Orr, and Richard Fox of Dynacs, Inc.; and Rick Rohan of Lockheed Martin Corp. Further information is contained in a TSP (see page 1). MSC-23810-1

Information Metacatalog for a Grid

Ames Research Center, Moffett Field, California

SWIM is a Software Information Metacatalog that gathers detailed information about the software components and packages installed on a grid resource. Information is currently gathered for Executable and Linking Format (ELF) executables and shared libraries, Java classes, shell scripts, and Perl and Python modules. SWIM is built on top of the POUR framework, which is described in the preceding article. SWIM consists of a set of Perl modules for extracting software information from a system, an XML schema defining the format of data that can be added by users, and a POUR XML configuration file that describes how these elements are used to generate pe-